A Field Guide to the Rangeland Vegetation Types of the Northern Province

Klamath, Mendocino, Shasta-Trinity and Six Rivers National Forests

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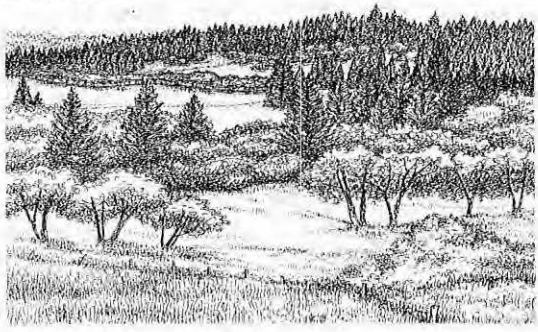

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ACKNOWLEDGEMENTS

The USDA Forest Service, Ecology and Range Management Programs funded this field guide. We thank the following individuals for their assistance in the development of the field guide: Jeff Jones, Bruce Bryan, Edward Biery, Richard Dwerlkotle, Peter Figura, Laura Andrews, Philip Purcell, Marla Knight, Curt Seeliger and Bud Adamson for ecology plot data collection; Jeffrey Tenpas, Tom Laurent, Tim Hagen and Mike Vollmer for soils data collection; Dr. John Tucker, for white oak systematics analysis; John Hunter, Kristin Schmidt, and John Alexander for wildlife input; Max Creasy, David Isle, Carol Molitoris, Judy Fessenden, Patricia Mortenson, Julie Nelson and Loren Roberts for support data; Peggi Lawrence, Steve Bishop, Mark Stromberg, Dave Weixelman, Bill Frost, Tom Frolli, John Willoughby and Kristin Schmidt for manuscript review; Scott Miles and Arnold James for advice on soils analysis and document structure; and Steve Bishop and Lou Woltering for project support and encouragement as well as input into document contents.

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INTRODUCTION

The USDA Forest Service range program is under intense scrutiny based on perceived livestock related effects on biodiversity, wildlife and fish habitat. These effects include shifts in plant species composition from perennial native species to annual non-native species as well as direct impacts to riparian habitats that affect fish and wildlife. One result of the perception of poor management practices by the Forest Service was to change its approach to management of the National Forests and Grasslands under its jurisdiction. This strategy, labeled Ecosystem Management, integrates ecological knowledge at various scales to produce desired resource values, products, services and conditions in ways that sustain the diversity and productivity of ecosystems. Ecosystem management is designed to conduct management and research with emphasis on maintenance of ecosystem processes and functions. The challenge of ecosystem management is to sustain ecosystems that are diverse, productive, resilient to short-term stress and able to respond to long-term change (Manley et al.1995).

To begin understanding ecosystem processes and functions requires a vegetation classification system. The Pacific Southwest Region (Region 5) of the Forest Service has begun a long-term project to develop an ecological classification system for the 20 million acres it manages in California. This classification follows others developed by federal agencies throughout the United States and will describe both existing and potential natural plant communities in a hierarchical manner. This hierarchy includes alliance or series, subseries and plant association classifications. Each level of the hierarchy is distinguished from the others by differences in species composition, soils, productivity, physiography and expected response to management (Allen 1987).

This field guide describes an ecological classification for rangeland plant communities, both existing and potential natural, in the Northern Province of California. Rangelands are lands that produce herbaceous forage and/ or woody browse or mast biomass fed upon by wild and domestic ungulates: deer, elk, feral hogs, sheep, goats, cattle, horses and mules, in the case of the Northern Province of California. Grasslands, meadows, chaparral, and oak woodlands are the primary biomes included in Northern Province rangelands. Additionally, after wildfire or clearcut logging, conifer forestlands act as transitory rangelands until trees shade out herbaceous forage and browse plants.

The objectives of this classification are:

1. to serve as a basis for ecologically-based management strategies (ecosystem management) in Northwest California (NW CA) rangelands;

2. to serve as a tool for evaluating compliance with the Northwest Forest Plan Record of Decision (Standards and Guidelines C-6);

3. to describe current successional status and potential conditions for NW CA rangelands;

4. to describe suggested management methods aimed at improving ecological status for NW CA rangelands; and

5. to serve as a basis for monitoring management effects on rangelands both the short and long-term.

Rangelands in the Northern Province

Grassland and rangeland ecologists have hypothesized that the wetter, more coastal-influenced parts of Northern Province grasslands and oak woodlands evolved with a greater dominance of native perennial grasses than in any other region of California. High rainfall and marine influences, particularly fog in summer, in an otherwise droughty Mediterranean climate is thought to be the reason for high perennial grass abundance. In characterizing California annual-type grasslands today, taxonomist Beecher Crampton often stated that more than 98% of the herbaceous biomass production in most California grasslands is from alien exotic annuals.

Many Northern Province annual grasslands are not typical of annual-type grasslands that occur in the Coast Ranges and Sierra Nevada foothills further south in California, although those occurring on the Mendocino National Forest at lower elevations are more typical. Many Northern Province annual grasslands occur at relatively high elevations with much greater precipitation and colder winter and early spring temperatures. Harold Heady (personal communication) considered 3,000 feet the upper elevational range for annual grasslands of the Sierra Nevada foothills. Much of our understanding of annual grassland comes from research conducted at the University of California, Hopland Field Station, in Mendocino County and the Sierra Foothill Range Field Station in Yuba County. Extrapolating findings from these sites would indicate that most grassland soils in the Northern Province are very deficient in nitrogen, phosphorus and sulfur. High leaching rates for nitrogen and sulfur would be expected with high precipitation and steep topography. Transformation of these grasslands from native perennial grass dominance to alien annual grasses probably has exacerbated the effects of nutrient deficiency. Perennial grasses capture, hold and recycle nutrients within the plant or through detrital root organic material immediately under long-lived bunchgrass lifeforms. This may help explain the common occurrence of depauperate annual grass species such as *Aira* and *Briza*, low productivity and litter accumulations, and relatively wide spacing among plants leading

to bare ground exposure. Relatively steep topography also contributes to leaching, high runoff, and removal of litter accumulations. The common ridgeline locations also expose these grasslands to wind effects which further speed litter fall and decomposition.

Historically, human influences on Northern Province rangelands have been less intensive than for most of California. Spatially isolated from the influences of Spanish settlements and Missions, the California gold rush, crop agriculture and urban development, the steep topography, isolated grassland glades in forest matrix, plus cold and wet winter climate have effectively restricted Northern Province rangeland exploitation. On the other hand, intensive forestry and periodic wildfire since the 1960s created extensive transitory rangeland, leading to a period of increased numbers of domestic livestock. With reduced logging activity and fire suppression, there has been a general decline in transitory rangeland forage resources over the last 20 years. These factors have also contributed to significant invasion of mountain meadows by confiers. Chaparral type-conversion and oak woodland manipulation by thinning or clearing in the southeastern part of the Northern Province during the 1960s and 1970s increased forage for livestock. Restrictions on predator control, particularly coyotes, have caused reduced sheep grazing since the 1960s. The Northern Province has the highest deer and elk densities in California. Feral hogs are abundant and continue to increase in some parts of the Province.

Fire, drought, grazing and their interactions influence the composition of rangelands at landscape, community and species scales. At the landscape scale, grassland, meadow and chaparral communities are closely associated with soils and hydrology (Heady et al. 1977). On drier sites, with thinner soils, chaparral species may encroach onto grassland where herbaceous plant vigor is low, sparse or disturbed by close grazing or erosion. Where chaparral vegetation occurs on well-developed soils capable of grassland vegetation, prescribed fire and livestock grazing tend to convert shrubland to grassland.

Chaparral vegetation management programs implemented to reduce wildfire hazard, and improve habitat for game mammals and birds and forage for domestic livestock, created large areas of grassland mosaics along ridgelines in some chaparral-dominated landscapes. The Grindstone Project on the Mendocino National Forest is the largest example of this management activity in California chaparral. Exotic, summer-dormant perennial grasses such as Harding grass (*Phalaris tuberosa*), and exotic annual clovers (*Trifolium* spp.) were seeded on these type-converted sites, but lack of maintenance management has allowed weeds to invade and shrubs to re-establish themselves. The noxious weed,

yellow star-thistle (*Centaurea solstitialis*), is colonizing some of these type-converted areas, especially where seeded perennial grasses are low in density. Research at Hopland indicates that these areas would have needed fertilization with phosphorous, reseeding with better-adapted annual clovers and periodic burning to maintain weed and shrub-free grassland.

There are differing opinions about the landscape dynamics of oak woodland communities in the Northern Province. Some scientists have hypothesized that Douglas-fir forest communities are replacing oak woodlands on mesic sites in natural succession processes. However, experienced forest ecologists feel that fire suppression is what is leading to this abnormal succession. In any event, the general statewide concern about poor oak woodland regeneration, due to inadequate recruitment of oak seedlings into the sapling stage, does not appear to be a problem for most of the Northern Province.

Community composition of most Northern Province grassland rangelands, particularly open grassland and oak woodland understory, is forever changed due to invasion of alien exotic herbs introduced from the Old World Mediterranean Region since the 1750s (Heady et al. 1977, Hektner and Foin 1977, Bartolome 1987). Most of the invaders are drought, fire and grazing adapted winter annuals. These species are highly adapted to California's cool-season winter growing conditions that typically begin with seed germination during October or November and end with seed shatter and plant death by June. In much of the Northern Province, plant phenology is delayed and growth continues well into summer. Where native perennial grasses dominate, resistance to invasion of alien annuals is high. Where the dominance of perennials is low, the annual-type grassland vegetation showspredictable inter-annual responses to drought, seasonally wet and late-spring rainfall. Woody plants in chaparral and oak woodland communities are almost exclusively native species.

Although they are rare in the Northern Province, severe winter droughts following fall germination in annual grassland kills most annual grass seedlings. With the death of most annual grasses, stand dominance shifts to drought tolerant tap-rooted herbs such as the non-native filaree (*Erodium* spp.). Seed output in spring therefore alters the community composition the next year, with more forbs and fewer grasses. Similarly, fire or close winter and early-spring grazing by domestic livestock favors forbs over grasses the following year. Typically, such carryover effects impact community composition for about three years. Usually by the fourth year after fire or drought, dominance shifts back to annual grasses. If close grazing continues, forb dominance tends to be maintained over time.

Most alien annual grasses are prolific seeders, so without drought, fire or close grazing, forb abundance remains low. Low productivity sites, like those on serpentine soils, support many forbs, including many rare taxa,

partly because the density of competitive annual grasses is low on these sites. The high diversity of forbs in most Northern Province grasslands is probably a result of low inherent productivity, as discussed above. Other disturbances such as trampling by large mammals, burrowing by gophers, and runway formation by deer mice and other small mammals also favor forbs, primarily by providing colonization sites. Annual grassland supports higher small mammal populations, especially granivores, than does native grassland with a large perennial component. During the dry season, most small mammals utilize sites with perennial grasses. During the green season, small mammals disperse into annual grasslands. Seed-eating small mammals either hibernate, move out of grasslands to shrubby vegetation, or eat stored seeds during the dry season. The high abundance of small mammals tends to counteract the effect of high grass density by disturbance mechanisms, favoring forbs on at least a local scale.

Many annual grassland plant community dynamics are driven by germinable seeds in the soil/surface litter seedbank. By way of definition, seedbanks are collectively the reservoir of seed accumulation on or near the soil surface, or suspended in littermats, that is available to germinate when conditions, within the seed itself and in the environment of the seed, permit imbibition of water and germination. The seedbank serves as both a budget and a buffer to maintain annual species, especially in a variable and risk-prone environment. It is the weed seed component in this seedbank that makes management of annual plant communities difficult.

Since most annual grass seeds in the seedbank germinate each year, annual grass composition is dependent on some plants completing their life cycle each year to produce propagules for the next year. During severe multi-year droughts like that of 1976-78 in the Northern Province, density of annual grasses becomes severely reduced. The grass plant's capacity to react to stress by tillering and producing many inflorescences per plant is expressed most strikingly when overall plant density and competition is extremely low. In 1977, sparse alien annual wildoat (*Avena* sp.) plants in eastern Mendocino County took on a perennial bunchgrass appearance with numerous tillers in a tufted structure with only three to five plants per square meter. In comparison, up to 10,000 annual grass plants per square meter commonly occur in annual grassland communities. The white oaks never leafed out during the height of this multi-year drought. The community took on a desert-like landscape appearance where the spacing among individuals was at a maximum, and the soil surface was essentially bare. More-normal precipitation over the next few years after the drought allowed recovery without lasting effects.

Annual clovers (*Trifolium* spp.) and medics (*Medicago* spp.) and many other fibrous-rooted forbs are not tolerant of periods of extended, within-growing-season drought. They tend to flourish in years with more evenly spaced rainfall. On productive sites, forb dominance is dependent on spring

grazing to remove taller grasses and litter that can shade out low-growing plants. Wildflower blooms, so popular with the recreating public, are often due to within-season and the previous season's livestock grazing of tall alien grasses, especially on productive sites where grasses dominate the community.

Small-seeded legumes are known for their production of high proportions of hardseed; i.e., seed with a testa or seedcoat impermeable to water for one or more years. Species with a hardseed seedbank exhibit asynchronous germination within and between years. This characteristic increases the chances that these species will remain in the community, since they tend to maintain a reserve seedbank capable of germinating when favorable conditions occur. Many other forbs also produce hardseed but not to the degree as do legumes. Hardseed for many species is unknown.

Filaree species have recently been found to require summertime heating of their seedbank in order to break dormancy and germinate (Rice 1985). This mechanism largely curtails germination under littermats produced annually by alien grasses such as wild oats and ripgut brome (*Bromus diandrus*), and multi-year litter accumulations of medusahead (*Taeniatherum caput-medusae*). This mechanism obviously increases the fitness of filaree, since individuals would not likely grow and reproduce under heavy litter. On the other hand, close livestock grazing on sites with large filaree seedbanks tends to cause filaree seed germination and increased forb abundance the following year. The filaree response is due in part to greater soil heating in summer, with low residual dry matter (RDM) levels due to consumption and/or trampling of litter. The emphasis given to discussing filaree, clover and medic species responses to fire, drought and grazing is because these are the most responsive plants to these processes, and they are relatively well-studied in comparison to less common native forbs.

When rainfall sufficient to germinate annual plants (> 15mm within one week) occurs unusually early in the year (late August or September), and is followed by a dry and warm period of three weeks or more, ecologists call such conditions a false break-of-season. Typically, the tap-rooted forbs such as filaree are the primary species to survive these events, while fibrous rooted forbs such as clovers and medics and the annual grasses rarely survive false breaks. Fall germination is a characteristic of alien annual plants in California's mediterranean climate. After-ripening processes within the seed do not allow seed produced in spring and early summer to germinate until mid-to-late summer during the year of production. False breaks may or may not shift community composition to forb dominance, depending on the quantity of ungerminated grass seeds remaining in the seedbank, and available for later germination the same year. Germination is often slowed significantly during the coldest winter period in December and January. Delays in potentially germinating rainfall

to this late date in the Northern Province may disallow germination until warmer spring temperatures occur. No work has been published on this subject for Northern Province rangelands.

Late spring rainfall benefits another group of alien annuals, the summer-annual forbs or weeds, such as yellow star thistle, a species with a very long-lived (8-10 year) seedbank. The so-called summer annuals germinate in fall like most annuals, but delay growth until warmer late-spring and early-summer periods, after most alien annual herbs have died. The noxious annual exotic grass, medusahead, while technically not a summer annual, has a somewhat later phenology than most annual grasses, and its seed production also increases with late-spring precipitation. Both weeds are especially prolific on sites with well-developed clay soils that provide soil water longer into summer. Yellow star thistle and medusahead are the most threatening plants to California grassland species diversity, as well as to rangeland forage productivity. Given the wetter late spring and summer conditions for many Northern Province rangelands, invasion potential by these noxious weeds is probably unusually high. Barbed goatgrass (*Aegilops triuncialis*), which was relatively uncommon until just a few years ago, also utilizes late spring moisture and is a very noxious annual grass. None of these weeds are palatable forage plants for wild or domestic ungulates. No goatgrass was observed during the monitoring of plots for this study.

Grassland fire consumes standing biomass and litter, including grass seeds suspended in the canopy or in surface litter. Forb seeds tend to fall through litter to the ground, or in the case of filaree's hygroscopic stipe, screw themselves into the soil surface below the effects of heat from fire. Forb seeds are generally less affected by fire than grasses. One result of fire, therefore, is increased forb-to-grass ratios. Livestock grazing prior to burning reduces fire intensity and the effects of heat on seeds near the soil surface. Therefore close grazing prior to burning reduces the effect of fire on annual plant communities. The grazing effect also applies to perennial grasses. Without grazing prior to burning, large fuel volumes can cause intense fire and high death rates of perennial grasses, up to 25% or more. With moderate livestock grazing prior to burning, perennial grass losses are usually less than 5%.

In recent years, there has been growing interest in restoration of native grassland communities. However, relatively little research has been done on management strategies to increase the abundance of native perennial grasses and forbs in annual-plant dominated communities. Research from other North American grasslands suggests that heavy livestock grazing use of perennial grasses should be avoided, especially during drought years. The combination of drought and grazing is a primary cause of death in perennial grasses. Heavy livestock grazing in spring is known to reduce the vigor, growth and seed production of perennial grasses.

Most native perennial grasses on upland sites in the Northern Province go into summertime dormancy, allowing them to endure the normal summer dry season. Grazing has less impact on perennial grasses when they are dormant, so summer grazing on dry grassland has little impact on plant health. Most perennial grasses complete their life cycle three to six weeks later than alien annual grasses. Reducing grazing pressure during this differential period can increase native plant seed production. Prescribed livestock grazing in remnant perennial grassland communities to increase their density is an important restoration practice. Early spring grazing, while annuals are flowering but before perennials are reproductive, can reduce transpiration and provide added soil water for perennials to reproduce. Unfortunately, this timing may also benefit summer-annual noxious weeds, so this management needs to be applied with consideration of the community as a whole.

In years following excellent seed production by existing native perennial grasses, prescribed livestock grazing can enhance native perennial grass seedling establishment. Grazing must be close enough during spring to allow enough light to penetrate to the ground level to benefit small native plant seedlings. Where alien annual grasses produce vigorous growth on highly productive sites, grazing in spring is imperative to native plant seedling survival. Periodic application of prescribed grazing during spring, for three to four years following excellent seed production years by native perennials, is likely the most promising management to restore remnant stands of perennial grasses and forbs to higher abundance. While this grazing practice may not be optimally timed for existing mature plants, so long as it is not too close, the benefits to seedling natives will outweigh any negative impacts on established plants. Mature native perennial grasses are very resilient to grazing, so long as abuse does not occur repeatedly.

Intense competition between alien annual grasses and native perennial grasses is particularly important at the seedling stage. Annuals go through the seedling stage every year. Perennials must, periodically, produce seedlings to sexually reproduce and evolve in changing environments. Perennial grasses have relatively weak seedling vigor compared to alien annuals, which typically have larger seed endosperms with more starch food reserves. Since alien annual grasses can out-compete the more depauperate natives very easily, manipulation of the fire or grazing environment of the seedling is critical in restoration programs.

Native plant seedling regeneration on sites where alien annuals are depauperate, such as on serpentine soils, is more successful than on more productive soils. Additionally, evidence suggests that native perennial grass seedling establishment occurs more successfully in droughty years

when alien annual plant competition is low. The same drought/seedling regeneration relationship has been shown for oak species where oak seedling survival is higher during years with dry spring conditions.

Study Area

The ecological sections of California (USDA 1997) were used to stratify the study area. Samples were collected in the Northern California Coast Section (263A), Northern California Coast Ranges Section (M261B), Klamath Mountains Section (M261A) and Northern California Interior Coast Ranges Section (M261C) (USDA 1997) (Fig. 1). These relatively uniform ecological units were mapped based on the associations of their biotic and environment factors that directly affect ecosystem function (McNab and Avers 1994). Understanding the key functional components operating in each section will help us better manage the rangelands under our jurisdiction.

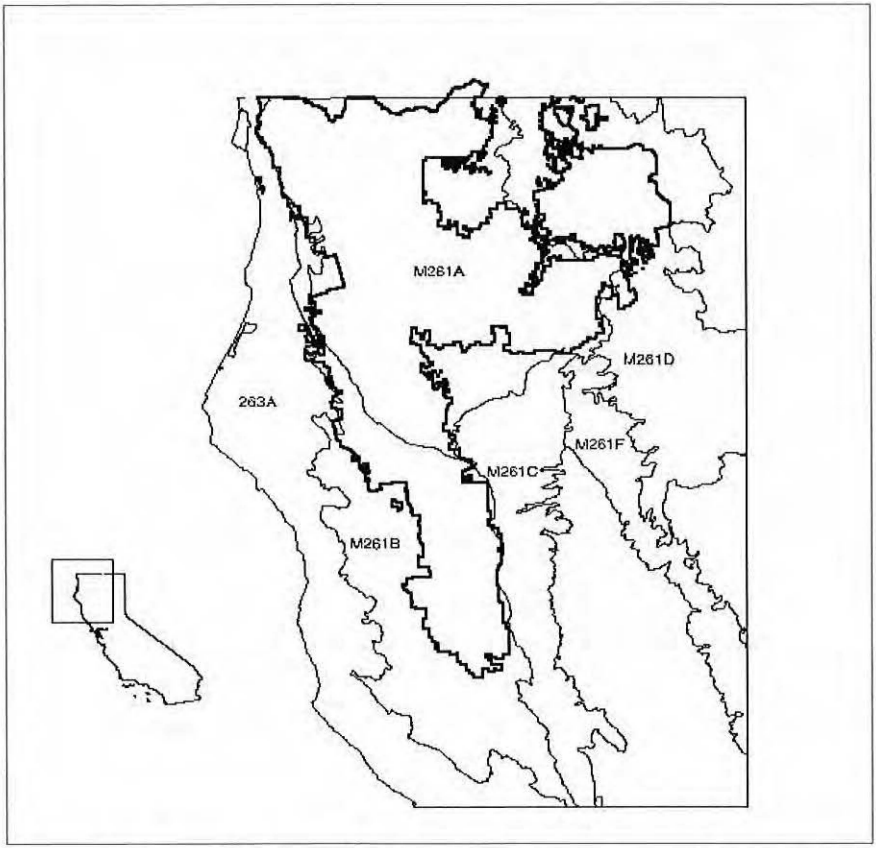


Figure 1. Map of the Northern Province forests covered by this guide (Klamath, Mendocino, Shasta-Trinity and Six Rivers National Forests) superimposed on the ecological units of this region of California.

Northern California Coast Section (263A): This section is composed of mountains, hills, valleys and plains in the northern California Coast Ranges. These parallel ranges are folded, faulted and metamorphosed late Mesozoic eugeosynclinal rocks of the Franciscan Formation and shelf and slope sedimentary rocks. The climate here is modified by marine influences. Summers are characterized by fog, cool temperatures and higher humidity than inland sites. Soils include Alfisols, Inceptisols, Mollisols, Spodosols, Ultisols and Vertisols in combination with isomesic, mesic orthermic soil temperature regimes and aquic, udic, ustic or xeric soil moisture regimes. Predominant potential natural vegetation communities include the redwood, Douglas-fir, tanoak, Oregon white oak, purple needlegrass, and coast live oak series.

Klamath Mountains Ecological Section (M261A): The Klamath Mountains Section is composed of steep to very steep dissected mountain ranges with elevations ranging from 400 to over 9000 feet. Paleozoic and Mesozoic aged geologic belts are comprised of stratigraphic formations and terranes containing igneous, sedimentary and volcanic rocks which have been accreted together and metamorphosed. Fluvial, glacial and mass wasting are the primary geomorphic processes in this Section. A variety of soils have developed from these rocks and unconsolidated deposits, including Alfisols, Entisols, Inceptisols and Ultisols in thermic, mesic, frigid and cryic temperature regimes with xeric and udic soil moisture regimes. Annual precipitation ranges from 20 to 120 inches. Predominant potential natural vegetation types include Douglas-fir, tanoak, canyon live oak, red fir, mountain hemlock, Port-Orford cedar, ponderosa pine, Jeffrey pine, white fir, Oregon white oak, black oak and gray pine forest series and a variety of chaparral and grassland vegetation types.

Northern California Coast Ranges (M261B): The Northern California Coast Ranges Section is composed of steep dissected mountain ranges with elevations ranging from 300 to over 8100 feet. Late Mesozoic marine sedimentary rocks of the Franciscan Complex, Mesozoic ultramafic rocks and Cenozoic volcanic rocks that have been folded, faulted and metamorphosed, underlie this Section. Mass wasting and fluvial erosion are the primary geomorphic processes in this Section. A variety of soils have developed from these rocks and unconsolidated deposits, including Alfisols, Entisols and Inceptisols in thermic, mesic and frigid temperature regimes with a xeric soil moisture regime. Annual precipitation ranges from 25 to 120 inches. Predominant potential natural vegetation types include Douglas-fir, tanoak, mixed conifer, white fir, ponderosa pine, blue oak and Oregon white oak forested series and a variety of chaparral and grassland vegetation types.

Northern California Interior Coast Ranges (M261C): The Northern California Interior Coast Ranges Section is composed of gentle to steep dissected mountain ranges with elevations ranging from 200 to over 3000

feet. Late Mesozoic shelf and slope sedimentary deposits that have been folded, faulted and metamorphosed dominate the Section. Mass wasting and fluvial erosion are the primary geomorphic processes in this Section. A variety of soils have developed from these rocks, including Alfisols, Inceptisols, Mollisols and Vertisols with a thermic temperature regime and xeric soil moisture regime. Annual precipitation ranges from 15 to 40 inches. Predominant potential natural vegetation types include blue oak, chamise, purple needlegrass and gray pine.

METHODS

Field work for this rangeland field guide was conducted in conjunction with the ecosystem classification program on the Six Rivers, Klamath, Shasta-Trinity and Mendocino National Forests in northern California. Plot data were collected in grasslands, oak woodlands, meadows, chaparral and conifer forests with range potential. Plots were stratified by environment and selected as study sites. Sampling methods generally followed those described earlier by Hall 1970, Moir and Ludwig 1983, and Allen and Diaz 1986. Sample plot locations were restricted to sites with homogeneous vegetation, seral stage, soils, geology and landform (Pfister and Arno 1980). Sample sites were selected after interviews with Forest personnel, a review of previous studies and the information on the factors described above and an extensive aerial photo and ground reconnaissance of the area. Plot size was 0.1 acre for herbs, graminoids and understory trees, and of variable radius for shrubs and overstory trees (Bitterlich 1947).

For each plot the following descriptive information was recorded: plot number, national forest, ranger district, forest map number, township, range, section, latitude and longitude (derived from GPS or ARC/INFO). Other variables are described below.

Environment variables

The physical environment was defined by elevation, aspect, percent slope, landform (general topographic characterization), micro-position (position of the plot on the slope), horizontal micro-relief (slope shape parallel to the contours), vertical micro-relief (slope shape across the contours), bare ground percent, surface gravel percent, surface rock percent, potential annual radiation (total annual radiation received for a given aspect, slope and latitude) (Frank and Lee 1966), transformed aspect (aspect transformed to a linear variable from 1-8) (Lewis 1982) and radiation index (ratio of total annual radiation on a given aspect and slope to total annual radiation received on a flat surface for a given latitude) (Frank and Lee 1966). In addition, annual precipitation, distance (miles) to the Pacific Ocean (X-coordinate) and position on the north/south gradient (Y-coordinate) (UTM) were determined from the ARC/INFO plot locations.

At selected sites, a soil pit was dug to a maximum depth of 60 inches or down to bedrock. For each pit, data were recorded on: percent surface

litter cover, litter thickness, parent material, parent material origin, total soil depth (to a maximum of 60 inches), rootability (whether the soil can be penetrated by roots), A horizon thickness, A horizon texture (using texture by feel), percent A horizon coarse fragments (using 2mm sieved soil samples), A horizon color (hue, value, and chroma using Munsell color charts) (Munsell 1975), sub-surface texture, percent sub-surface coarse fragments, sub-surface color, soil drainage class, available water holding capacity (AWC) for the top 20 inches of soil, soil name (classified to family), pH of the surface horizon (using a Hellige-Truog Soil Reaction Tester) and pH of the sub-surface horizon.

Vegetation variables

At each 1/10 acre plot, total percent cover was visually estimated and recorded for moss, forbs, graminoids, shrubs and trees. All plants were identified to species where possible (nomenclature follows Hickman 1993). Abundance was recorded for the herbaceous and graminoid layers only (Allen and Diaz 1986). Estimates of tree height and standing basal area (basal area factor 20 or 40) were recorded at three points per plot using a Speigel relaskop. In addition, diameter at breast height (dbh), tree age, 10 and 20 year radial growth were recorded for a minimum of one dominant tree per point.

Prism data

Prism variables are computer generated climate data that were added to the plot data set to help explain the variability of rangeland communities. The climate data was derived from precipitation and temperature map surfaces generated by the Precipitation-elevation Regression on Independent Slopes Model (PRISM) (Daly et al. 1994, Daly et al. 1997). This model uses digital elevation models (DEMs) to account for topographic effects in interloping weather measurements from an irregular network of weather stations to a uniform grid. Thirteen precipitation and thirteen temperature map surfaces (mean annual and 12 mean monthlies) were generated at 4 km resolution from 1961-1990 weather data. The precipitation data were specifically for California and Oregon, respectively, and the temperature data were for the conterminous United States. These map surfaces were imported as ARC/INFO grids. Indices developed by Ohmann and Spies (1998) were computed from the mean monthly precipitation and temperature values for each grid for both the California and Oregon data. The temperature indices used were Mean annual temperature (ANNTMP), Mean August maximum (AUGMAXT), Mean December minimum (DECMINT), Mean Summer temperature (SMRTMP), and the difference between the mean August maximum and the mean December minimum (DIFTMP). Some of the precipitation values were log-transformed because vegetation does not respond linearly to amount of precipitation. A 1.0 cm difference in precipitation is more important at low

than at high levels (Ohmann and Spies 1998). The precipitation indices used were as follows: the log of Mean Annual Precipitation (ANNPRE), Mean Annual Precipitation (PRISMPPT), and the log of Mean Summer Precipitation (SMRPRE). Seasonal variability and continentality indices for the precipitation layer were also computed. Continental climates experience less seasonal variability in precipitation because of increased prevalence of rainfall from summer convective storms. This is reflected in the CVPRE and CONTPRE indices. The Precipitation and temperature indices developed from the grid layers were assigned to each rangeland plot location using bilinear interpolation (LATTICSPOT function, ESRI 1991).

Data analysis

The vegetation and environment data were analyzed using the following programs and statistical packages.

Vegetation classification: Initial classification was accomplished using the polythetic divisive classification technique, Two-way Indicator Species Analysis [TWINSPAN] (Hill 1979). Polythetic divisive techniques have a theoretical advantage over agglomerative techniques since all available information is used to make the topmost decisions. TWINSPAN requires species cover values to avoid unacceptable rates of misclassification (Gauch 1984). It uses information on all species to group the plots based on similarity of species cover values. The data are first ordinated by reciprocal averaging with the extremes positioned at the polar ends. The samples are then divided into 2 clusters and the process is repeated until some minimum group size is achieved (Gauch 1984). This minimum group adds an element of subjectivity to the classification. This subjectivity can be reduced by applying the "stopping rule" of Hill (1980). Gauch (1984) recommends TWINSPAN because it is effective, robust, uses the original data in the classification rather than a similarity or dissimilarity index, integrates both samples and species, and places most similar samples together. One requirement of classification is that it must have heterogeneous communities to work, because some statistical programs will classify even a random data set (Ludwig and Reynolds 1988). TWINSPAN works best when paired with an ordination technique like the indirect gradient analysis tool, detrended correspondence analysis (DECORANA) (Hill 1979) and the direct gradient analysis tool, canonical correspondence analysis (CANOCO) (Ter Braak 1986) described below.

Direct gradient analysis: Direct gradient analysis was performed using canonical correspondence analysis [CANOCO] (Ter Braak 1988, Jongman et al. 1995). This technique constrains the ordination of the main matrix (species cover) by a multiple regression on environmental variables contained in the secondary matrix. CANOCO was used as the primary tool

to define the environmental gradients that best explained the variability of rangeland communities (McCune and Mefford 1995). The analysis was done in a stepwise manner beginning with the full data set. This initial ordination helped to identify the primary gradients influencing species composition within rangeland communities. The final partitioning involved a separate analysis of each alliance or series (dependent on sufficient plot numbers) to identify the environmental gradients affecting rangeland plant associations. In situations where the identified gradients were so long that they masked other important environmental gradients a second iteration of the analysis was run. The results of the direct ordination are presented both descriptively and in graphic form. First, key correlated variables are described in relation to rangeland plant associations. Second, the position of each plant association in relation to the primary environmental gradients is presented. Last, the environmental gradients are used to help describe plant association relationships.

CANOCO was used next to refine the classification by identifying the primary environment gradients. CANOCO is an extension of DECORANA, it is a direct gradient analysis technique designed to discover how a multitude of species respond to external environment variables (Ter Braak 1992, Palmer 1993).

The vegetation classification was further refined with Stepwise Discriminant Analysis (Jennrich and Sampson, 1985). Discriminant analysis forms linear combinations of the independent variables and uses them to classify cases into groups (Norusis 1992). Discriminant analysis is used to test membership in each group identified above and to identify the discriminating species and environmental variables. It identifies plots that are misclassified through posterior probabilities of group membership and lists the variables correlated with each discriminant function. Discriminant analysis, species/environment scattergrams and linear regression were used to identify plants with indicator species value. Indicator species are key to this classification and are those species that reflect changes in the environment.

The vegetation classification described in this Guide should be considered a first approximation. The classification may change in the future as new information is added.

Stand structure analysis: The program Forest Inventory Analysis (FIA) (USDA 1986), was used to analyze the tree data. Information generated by these programs included: standing cubic volume, cubic volume growth, basal area, basal area growth, site class, and trees per acre by species and dbh class.

The stand structure characteristics by layer were derived from the growth information collected on the FIA card described above. All seral stands

were included in this analysis to understand the changes in stand structure related to stand age. Trees were classified into layers based on a minimum of 10% difference in height. From this data the number of layers were described along with mean age, dbh and height by layer.

The statistical package SPSSPC+ (Norusis 1992) was used to develop descriptive statistics (mean, standard deviation and standard error) and to calculate stand density index (SDI) (Reineke 1933).

Species diversity: The concept of species diversity as a tool in the examination of plant communities has been intensely debated. We believe it is a necessary part of this classification analysis and will discuss it here at various scales, particularly in light of 1) the controversy surrounding the effects of non-native species on native species diversity, and 2) the utility of classification as a tool in managing for the maintenance of species diversity.

Species diversity is composed of two components: (1) richness (the total number of species), and (2) evenness (how the data are distributed among the species) (Ludwig and Reynolds, 1988). Three diversity measures were used here: species richness, evenness and Shannon diversity index. Species richness is the number of species identified on each plot. Evenness examines how the data are distributed among the species. For example, evenness values that approach 1.0 indicate that species cover is more evenly distributed; in contrast low values of evenness indicate uneven cover spread among the species. Shannon diversity index combines both species richness and evenness into a single value. The value for Shannon diversity index is zero if there is only one species on a plot. It increases toward maximum, when all species on a plot are represented by the same percent cover (perfectly even distribution). These diversity measures were calculated for each plot using the program PC-ORD (McCune and Mefford, 1999).

A species richness comparison for annual grasslands, meadows, chaparral and oak woodlands found significant differences by vegetation type (P=.0001) (fig. 2.). Species richness ranged from a low of 3 species/plot to a high of 49 species/plot and averaged 21.4 species/plot. The oak woodland vegetation type had significantly higher richness (X=25.3 species/plot, range 5-49 species/plot) than all other vegetation types. The chaparral type had the lowest species richness (X=18.0 species/plot, range 4-36 species/plot). This wide contrast is likely due to the moist, partially shaded environment of oak woodlands and the dense shrub layer found in chaparral. No significant difference in species richness was found between annual grasslands (X=21.1 SE 0.5, range 9-37 species/plot) and meadows (X=21.6 SE 0.6, range 3-47 species/plot).

The evenness analysis also found significant differences by vegetation type (P=.0001). The Northern Province Rangelands ranged from an uneven distribution (0.344) to a nearly even distribution (0.979) of plant species

(average 0.688). The highest degrees of evenness were found on the meadows (0.719) and annual grasslands (0.717). The oak woodlands and chaparral types had a more uneven distribution (0.637 and 0.663 respectively).

The Shannon Index analysis also found significant differences by vegetation type (P=.0001). The highest Shannon Diversity Indexes were found in the meadow (2.17) and annual grassland (2.16) vegetation types. The lowest Shannon Diversity Index was found in the chaparral (1.85) vegetation type. The oak woodland type had an intermediate Shannon Diversity Index rating (2.03) that was not significantly different from the average for all rangeland types (2.06).

Further comparisons at the alliance or series level are displayed in the introduction to each section (annual grasslands, meadows, oak woodlands, chaparral etc.). It is also compared and displayed as a mean value for each plant association in the plant association description sections.

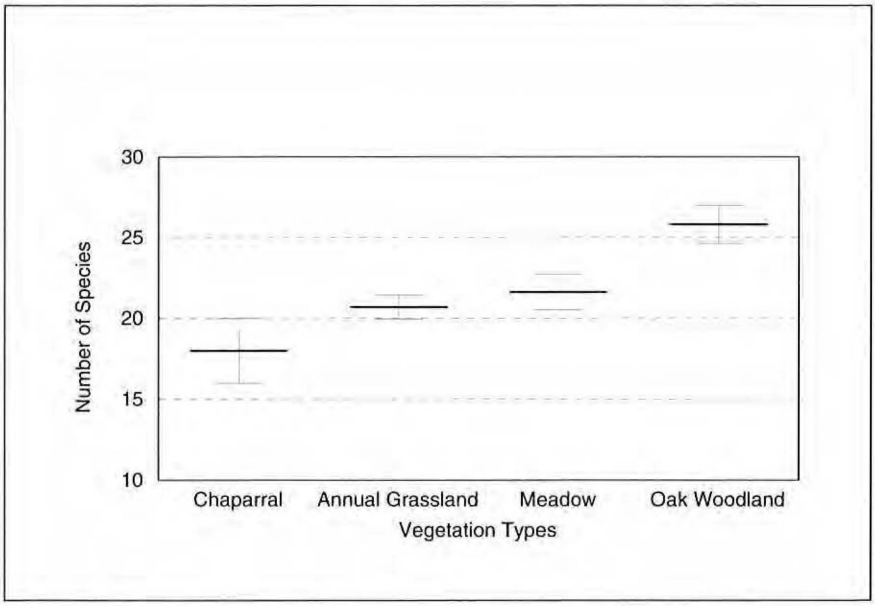


Figure 2. Mean species richness comparison by vegetation type, with 95% confidence interval.

Annual grassland, oak woodland, meadow and chaparral vegetation types have differing degrees of non-native plant invasion that are primarily limited to herbaceous species. Annual grasses are the primary non-native invaders of annual grasslands and oak woodlands although non-native forbs are important invaders as well. Within each vegetation type, evenness and

Shannon diversity indices are used to evaluate plant species diversity. Species richness and cover of native vs. non-native species are used to develop goals for rangeland management. Because of the greater diversity of non-native compared to native grasses and the high degree of invasion in existing communities, setting management goals for a greater component of native species in annual grassland and oak communities is warranted.

Non-native annual grasses have the primary influence on annual grassland and oak woodland understory species diversity. They achieve this role by virtue of their relatively high cover and greater number of species compared to native grasses. Additionally, they compete with native species and displace them and yet do not fully utilize soil water and nutrient resource as do the more deeply rooted native perennial grasses. This results in higher resource availability to other weeds, especially tap-rooted species. Setting a goal for the two vegetation types of at least 25% of the grass cover composed of native grasses and a 1:4 ratio of native vs. non-native grass species counts would be a worthy achievement. The goal for forbs should include at least 75% of forb cover composed of native forbs and a 4:1 ratio of native vs. non-native forb species counts.

Ecological Status:
This section will first describe the existing condition of rangelands in the Northern Province from several perspectives. These include comparisons of cover and species counts of grasses, grass-like plants and forbs, annuals and perennials and native and non-native species. The ecological status will be described using assigned seral species status (USDA Forest Service 1997), a short-term (1-5 year) disturbance related classification in annual grasslands and oak woodlands, and presence of noxious and invasive exotic weeds. Range management methods will be discussed that aim toward recovery of these systems toward higher ecological status and range health.

Seral status:
Plant species are often used as indicators of ecological status (early, mid or late seral) since they tend to reflect site potential, site history and past management activities (USDA Forest Service 1997). Species were designated as indicators of early-seral, mid-seral or late-seral conditions as defined below:

Early-seral - species associated with very disturbed or young associations (pioneer species), with low abundance in stable associations, but invasive with high abundance inunstable associations.

Mid-seral - species whose abundance increases significantly with increased disturbance and maintains high abundance in recovered, stabilizing associations.

Late-seral - species typically found in undisturbed associations that decrease or maintain low abundance with increased disturbance.

Seral status is used to evaluate the current condition of each plant association by totaling the vegetation cover in each seral state. Seral state cover is calculated by plot and averaged across association or alliance. These values can then be compared against site potentials for each plant community, where they are known, with an overall objective of increased late seral cover.

Disturbance related classification:
Some non-native annual grass species and forbs exhibit short-term responses to disturbance including grazing, fire and drought (Sampson et al. 1951, Heady et al, 1977). For example in annual grasslands and oak woodlands, taller grasses such as *Bromus hordeaceus, Avena barbata, Avena fatua* and *Bromus diandrus* indicate less recent disturbance while *Hordeum* and *Vulpia* species are disturbance related. *Aira caryophyllea* and *Briza minor* indicate the greatest degree of disturbance, often including trampling and compaction effects of livestock with minimal soil surface litter accumulation. *Hordeum murinum* ssp. *leporinum* is also an indicator of high disturbance and is promoted by manure and high nutrient accumulation where livestock tend to concentrate and bed down in shade or on ridgelines.

This section proposes a short-term (1-5 year) disturbance related classification for selected annual grasses and forbs in annual grasslands and oak woodlands. The species proposed for this analysis and their disturbance relationship are given in Table 1. Recent disturbance history is assessed by totaling the vegetation cover of these non-native annual grasses in each disturbance category. Disturbance level is calculated by plot and averaged across association or alliance. Additionally, abundance of seven selected forbs is used to enhance the interpretation of recent disturbances.

Table 1. A short-term (1-5 year) disturbance related classification of selected Northern Province annual grasses and forbs (modified from Heady et. al 1977).

High disturbance	Medium disturbance	Low disturbance
Aira caryophyllea	*Bromus madritensis rubens*	*Avena barbata*
Briza minor	*Gastridium ventricosum*	*Avena fatua*
Bromus tectorum	*Lolium multiflorum*	*Bromus diandrus*
Hordeum marinum gusson.	*Vulpia microstachys*	*Bromus hordeaceus*
Hordeum murinum	*Vulpia myuros*	*Erodium cicutarium*
Poa annua	*Daucus pusillus*	
Lupinus bicolor	*Erodium botrys*	
Madia spp.	*Medicago polymorpha*	
Trifolium spp.		

Range management methods: Controlled livestock grazing (rotation, not season-long) with managed utilization (residual dry matter, RDM-based) will ultimately increase abundance of low disturbance-related taller grasses such as *Bromus hordeaceus*, *Avena barbata*, *Avena fatua* and *Bromus diandrus*. Highly disturbed communities of *Aira caryophyllea*, *Briza minor* and *Bromus madritensis* ssp. *rubens* will shift to a dominance of these taller grasses under grazing management. The mechanisms for this are shading and litter accumulation on the soil surface that impede the short-statured grasses. The more vigorous root systems of the taller grasses will tend to make surface soils more friable and conducive to root penetration and water infiltration, aiding perennial grass establishment. Moderate seasonal or short-duration grazing of the taller annual grasses is critical to establishment of native perennials since shade and water competition from tall annuals can suppress regenerating perennials. Mature native perennial grasses must be sufficiently abundant initially to serve as a seed source for their seedlings to regenerate. Successful establishment will likely occur during wet years. Higher late seral cover will develop with seasonal livestock use and lighter stocking rates. The rate of replacement of late seral annuals by native perennials may be enhanced by seeding.

It is unlikely that *Aira caryophyllea*, *Briza minor* and *Bromus madritensis* ssp. *rubens*-dominated communitites could be directly transformed directly to one dominated by late seral perennials. The mechanism of change works through the soil and litter environment in addition to the canopy shade environment. *Aira caryophyllea* and *Briza minor* especially are indicators of compacted soils, and dry site conditions with low or non-existent litter accumulation. They also are common on cold, wet, north-facing sloped sites where soils are nutrient deficient and show little production potential. Compacted soils with little litter accumulation are not conducive to perennial grasses seedling establishment given their weak seedling vigor. As discussed above, livestock grazing has a role in manipulation of the light canopy and litter. The unpalatability of *Taeniatherum caput-medusae* is an exception. It cannot be manipulated by grazing alone and prescribed fire must be used.

Management Emphasis Rating

In the Northern Province, rangeland management issues are strongly related to the aquatic conservation strategy, listed fish species, water quality, noxious and invasive weeds and plant species diversity. Steep topography, sedimentary derived soils, earth movement, and high rainfall leads to deposition of soil material into streams and negative impacts to fish populations, water quality and site productivity. High bare ground and surface gravel and rock cover are an indication of past heavily eroded surfaces that have reduced productivity. These degraded sites are much more susceptible to invasion by noxious and invasive weeds. Non-native

species invasion has lead to significant reductions in cover of perennial grasses and likely reductions in species diversity. The objective is to manage rangelands in such a way as to minimize these negative effects. To do this through management for full canopy coverage by herbaceous plants with deeply rooted perennial root systems, increased litter cover for surface soil protection, improved soil structures that promote rapid percolation and minimize runoff and improved balance of native to non-native plant species in the low disturbance category is suggested.

Management emphasis rating (MER) is a system proposed for prioritizing Northern Province rangelands for management treatment. The system is based on the cover of bare ground and litter, the cover of surface gravel and rock, the cover of noxious and invasive exotic weeds and the cover of disturbance related species that are competitive with more desirable plants. The rating system includes three categories high, moderate and low based on these factors. For example a high management emphasis rating would be applied to a site with high surface gravel and rock cover (> 20%) and bare ground (> 20%), low litter cover (< 20%), presence of noxious and invasive weeds at levels conducive to management, and dominance of species related to high levels of disturbance. Not all of these factors need to be present on a site to receive a high MER. This rating is subjective, professional judgment is key in evaluating site conditions. In contrast a low management emphasis rating would be applied to a site with low bare ground (< 10%), low surface gravel and rock (< 10%), litter cover (> 40%), absence of noxious and invasive weeds, and dominance of species in the low disturbance category. A moderate emphasis rating would be intermediate between the two examples.

It is suggested that management emphasis rating be assigned to each rangeland plot and the assigned rating be plotted on range allotment maps. This will allow for the development of an overall management emphasis rating for each range allotment or portion of an allotment based on plant association-based management strategies. Those allotments identified with a high MER would have their allotment management plans modified. It is suggested that these modifications be based on treatments discussed in the rangeland field guide.

Indicator Species

Over the last half-century, rangeland managers made substantial efforts to monitor plant communities to better understand livestock grazing effects on vegetation and soils. During the last two decades, they have worked with other biologists and physical scientists to improve wildlife, fisheries, hydrologic and soils resources through prescriptive grazing. Today, ecological functioning and structural diversity of rangeland ecosystems have become primary goals of range management. These new goals have

broadened the need for vegetation attributes that managers can measure to assess rangeland and adaptively manage livestock grazing. Ecological analysis and plant community classification helps identify indicator plant species within communities, which can predict ecological status and capacity of communities to produce resource values and perform ecosystem functions.

Rangeland ecosystems are complex communities of terrestrial and aquatic vegetation and soils with species that have evolved, and continue to evolve, mechanisms to adapt to grazing, fire and drought cycles. Grasses and grasslike plants in particular have an array of structural and physiological attributes which indicate their capability to tolerate, resist or withstand defoliation and trampling impacts, intense fire and drought. These adaptations have a genetic basis that indicates long-term coevolution of herbivores with vegetation and soil biota, fire and drought.

As an example, cespitose perennial bunchgrasses store organic forms of nitrogen, phosphorus, and other nutrients in the top meter of soil below individual grass clumps. Vegetative reproduction of bunchgrasses involves cloning themselves into competing ramets (cloned individuals), together forming the long-lived bunchgrass. Nutrients required for plant and animal growth and survival are recycled locally by this plant/herbivore/decomposer system at all temporal scales throughout the life of the grass plant. Bunchgrasses have most of these localized nutrient resources available to them in very slowly decomposing humus derived from their roots and litter. Herbivores grazing these plants return 80- 95% of the forage nutrient content to the soil in patch depositions upon and among existing plants, providing a diverse distribution of surface nutrients to new and existing plants (Heady 1975). Phosphorus is the one element that may show a significant depression in soil availability over time (Stromberg and Griffin 1996). Bunchgrass survival and competitive ability with weedy annual grasses and forbs following catastrophic fire, drought, heavy grazing, or a combination of these disturbances is dependent on these localized resources.

Since range plants exhibit a diverse array of tolerances to fire, drought and grazing effects, their abundance and landscape patterns can provide managers with useful indications of past grazing impacts. Information concerning species responses comes from many sources including research, applied studies, and other documented observations. This information has been compiled and presented here for each vegetation type (annual grasslands, oak woodlands, montane meadows, etc.) for use by resource specialists to help choose appropriate indicators and interpret monitoring data on rangelands.

Western rangelands for the most part have a history of grazing abuse in terms of overstocking, poor animal distribution practices, and introduction of exotic species, especially in California following Spanish colonization. Settlement by people from Old World areas of similar climates predisposed California to pre-adapted plant introductions. The land development boom caused by the 1849 Gold Rush further promoted exploitative land use. The result is that many of the existing vegetation and soil conditions in California show the effects of past mismanagement. Without exception, however, stocking rates of livestock today are only a fraction of past levels.

With the exception of mountain meadows, most grasslands in California, including the herbaceous understory in oak woodlands, are dominated by introduced annual grasses. Yet, these communities support many forbs of which natives are usually much more common than non-natives. Most non-native annual grasses and forbs have become naturalized, and without extraordinary restoration effort they will remain dominant members of these communities. Natural succession processes for these communities are altered since late-seral perennial grasses normally cannot out-compete the prolific annuals in order to achieve late-seral stage conditions. However, within many communities of introduced annual grasses and forbs, predictable replacement seral species, or "quasi-succession," does occur. This has been recognized since the time of Frederick Clements' visit to California in the 1930's and has been discussed by Sampson and Heady. Strategies to increase abundance of late-seral natives is a worthy goal, but expecting dominance is unrealistic in most situations. In trying to meet this goal, it is useful to accurately interpret vegetation changes, including replacement seral species, within communities of introduced annual grasses and forbs.

A large literature exists justifying changes in plant community composition and bare soil exposure as indicators of grazing impacts (NRC 1994 and Ratliff 1985). We will not review that literature here except to say that excessive defoliation and trampling can, both temporally and spatially, selectively reduce the growth capacity of individual plant species, thereby reducing their fitness and survival. This leads to changes in plant community composition. On the other hand, lack of herbivore (wildlife and livestock) grazing in grazing-adapted ecosystems such as grasslands and meadows can lead to unnatural plant compositions, especially in those ecosystems subjected to exotic plant invasion or high litter accumulation. Over time, the plant community composition reflects grazing effects. Since soil is the ultimate resource supporting terrestrial biota, changes in soil exposure to erosion indicate potential risk for soil loss and therefore sustainability. Thus, reduction in bare soil on range allotments is a second important indicator of good stewardship.

The potential underlying causal mechanisms for plant community changes are numerous, including 1) reduced rooting depth and water uptake by native plants in excessively trampled and closely grazed grasslands, 2) shading out small plants by large tall plants and their litter accumulation, combined with little or no grazing in highly productive grassland, 3) lowering of water tables due to gullying, thereby shifting composition to species suited to drier soil conditions, and 4) inadequate reproductive success due to frequent seedhead removal and aggressive weed competition.

Much is known about some grass and grasslike species, which indicate quite different environmental and grazing impacted conditions. Much of this species-specific information was developed from the collective experience of range scientists, specialists and ecologists, and from reference material, including the Range Plant Handbook (USDA Forest Service 1937). A discussion of a limited number of grasses, grasslike species and forbs is presented in the introduction to each of the major vegetation types described in this guide.

Noxious and Invasive Exotic Weeds

The USDA-USFS policy definition of noxious weeds is as follows: "Those plant species designated as noxious weeds by the Secretary of Agriculture or by the responsible State official. Noxious weeds generally possess one or more of the following characteristics: aggressive and difficult to manage, poisonous, toxic, parasitic, a carrier or host to serious insects or disease and being non-native or new or not common to the U.S. or parts thereof ."

On Northern Province Forests, there are several exotic plant species of concern to land managers that are not officially listed but share the same invasive characteristics. The California Native Plant Society defines an invasive exotic weed as, "one that is able to proliferate and aggressively alter or displace indigenous biological communities." In California, many of these species are listed and tracked by the state California Exotic Plant Pest Council (CalEPPC 1999). Species identified by Northern Province Forests as noxious weeds are listed in Table 2.

Noxious and invasive exotic weeds are a continuous and increasing threat to native ecosystems and the function of plant communities. As well as being a range problem, they are also a serious biodiversity issue of significant importance to resource values within the Northern Province (Williams 1999). All ecosystems are vulnerable to invasion by non-native weed species, though given the shade intolerance of most noxious weeds found in the Northern Province, open settings are most vulnerable.

Table 2. Noxious Weeds and Invasive Species as Reported by Northern Province Forests for the Provincial Noxious and Invasive Weed Strategy in 1999.

Species	Common Name	Species	Common Name
Aegilops cylindrica	goatgrass	*Elytrigia repens*	quackgrass
Brassica nigra	black mustard	*Euphorbia esula*	leafy spurge
Bromus tectorum	cheatgrass	*Foeniculum vulgare*	fennel
Cardaria draba	white-top	*Genista monspessulana*	French broom
Carduus acanthoides	plumeless thistle	*Hypericum perforatum*	klamathweed
C. nutans	musk thistle	*Isatis tinctoria*	dyers woad
C. pycnocephalus	Italian thistle	*Lepidium latifolium*	perennial peppergrass
Centaurea calcitropa	purple knapweed	*Leucanthemum vulgare*	oxe-eye daisy
C. diffusa	diffuse knapweed	*Linaria genistifolia* ssp. *g.*	dalmatian toadflax
C. maculosa	spotted knapweed	*Lythrum salicaria*	purple loosestrife
C. melitensis	tocalote	*Melitotus alba*	white sweetclover
C.nigra	black knapweed	*Mentha pulegium*	pennyroyal
C. repens	Russian knapweed	*Onopordum acanthium*	Scotch thistle
C. solstitialis	yellow starthistle	*Onopordum tauricum*	taurian thistle
C.squarrosa	squarrose knapweed	*Parentucellia viscosa*	parentucellia
Chondrilla juncea	skeletonweed	*Robinia pseudoacacia*	black locust
Cirsium arvense	Canada thistle	*Rubus discolor*	Himalayan blackberry
C. vulgare	bull thistle	*Salvia aethiopos*	mediterranean sage
Conium maculatum	poison-hemlock	*Senecio jacobaea*	tansy ragwort
Convolvulus arvense	field bindweed	*Sonchus arvensis*	perennial sow-thistle
Cortaderia jubata	jubata grass	*Sorghum halepense*	Johnson grass
C. selloana	pampas grass	*Taeniatherum caput-medusae*	medusahead
Cynosurus echinatus	hedgehog-dogtail	*Ulex europaeus*	gorse
Cyperus esculentus	yellow nutsedge	*Verbascum thapsus*wooly	mullein
Cytisus scoparius	Scotch broom		

In general, noxious and invasive exotic weeds tend to be opportunistic, aggressive colonizers, and prolific seed producers, often producing a long-lived seed bank. They are able to take advantage of site disturbance to rapidly establish themselves under many climatic and edaphic conditions. Invasive weeds tend to be either self-pollinated, pollination generalists or wind-pollinated. They generally have heavier seeds, and are often winter annuals. Over two-fifths of the noxious and invasive weeds in California are annual members of the sunflower (Asteraceae) or the grass (Poaceae) families (Mooney and Drake 1986).

The effects of noxious and invasive exotic weed intrusion on native ecosystems can be devastating. Weeds can readily dominate an area, out-competing native plants for moisture, nutrients, light and space, thus discouraging their reproduction. Pollination generalists are more successful at attracting pollinators, resulting in a larger seed set for the invaders, and

potentially reducing genetic diversity in natives with more specific pollination systems (Schierenbeck 1992). Heavier seeds withstand drought more easily. Winter annuals are able to take advantage of moist conditions to establish themselves before native perennials have even germinated. Annuals including members of the sunflower and grass families tend to produce large quantities of seed. Annual grasses may produce multiple generations within the growing season.

Over time, the establishment of noxious and invasive exotic weeds changes the composition and structure of the vegetation above and below ground. This may result in: reduction of biological diversity; alteration of successional patterns, nutrient cycles and the energy flow through the food chain; degradation of soil structure with increased potential for erosion; alteration in disturbance cycles; and genetic contamination, including both rapid genetic change of the colonizers after their establishment and through their hybridization with native species (Mooney and Drake 1986).

Annual exotic grass establishment leads to changes in soil structure as the shallow, short-lived root systems of annual grasses are neither able to utilize and recycle deep soil nutrients and moisture nor hold the soil in place during wet months, as the extensive fibrous root systems of perennial grasses do. Soil microbial communities in annual grasslands are different than microbial communities in native perennial grasslands. Sites dominated by annual grasses become increasingly less fertile, more arid and less productive over time, as well as more susceptible to erosion. Tap-rooted winter annuals such as thistles and knapweeds also affect soil hydrology by decreasing the water-holding capacity of the soil and increasing erosion. For example, plots dominated by spotted knapweed (*Centaurea maculosa*) were documented as increasing surface runoff and subsequent sediment yield in rangelands by 56% and 192% respectively, over paired bunchgrass-dominated plots in experiments in Montana (Lacey 1996). Another example is yellow star-thistle (*Centaurea solstitialis*), a common invader of many summer-dry, open habitats. Yellow star-thistle germinates from fall through spring, and by late spring its roots may extend over three feet into the soil profile, enabling it to out-compete shallow-rooted annual species during dry months. This plant forms dense infestations that rapidly deplete soil moisture, preventing the establishment of other species.

Another factor affecting natural succession is accumulation of litter in annual grasslands. For example, herbage of medusahead (*Taeniatherum caput-medusae*), an increasingly common member of annual grasslands on clay soils, is high in silica, which retards decomposition. The resultant accumulation of litter can persist for over two years, inhibiting germination of other species. At the same time, build-up of litter leads to seasonal nutrient flushes that encourage the growth of more invaders. Thus, natural

succession is slowed as sites initially occupied by scattered medusahead plants become nearly pure stands devoid of native species.

Medusahead, yellow star-thistle and the ubiquitous cheatgrass (*Bromus tectorum*) are winter annuals that are able to germinate and establish root systems at lower temperatures than native perennial grasses. Harris (1967) found that roots of cheatgrass seedlings developed about 50% faster than roots of the native perennial, bluebunch wheatgrass (*Pseudoroegneria spicata*). Plants develop when moisture is abundant and are well established by the time conditions favor germination of native perennials. Cheatgrass, like medusahead and yellow star-thistle, is extremely tenacious and can provide such intense competition to other newly emerging seedlings that few native plants are able to become established (Monsen 1992).

Factors influencing change in community structure, such as competing annuals and depletion of soil moisture are not temporary, but constitute a shift in successional patterns to a self-perpetuating annual community. Perennial grass seedling vigor is sufficiently less than that of exotic annual grasses that establishment rates are comparatively low. Without intervention, such as weed fallowing by mechanical or chemical means, restoration of native perennial grass dominated communities is unlikely. Grazing alone or in combination with prescribed fire is normally insufficient to put succession back on track (Menke 1989).

The colonization of rangelands by noxious and invasive exotic weeds impacts both livestock and wildlife by reducing habitat values. For example,replacement of perennial grasses with shorter-season, exotic annual grasses reduces the period green forage is available to livestock and wildlife (Bentley and Talbot 1951). Green forage provides higher vitamin A and protein and better digestibility. Perennial grasses stay green longer in spring and typically green-up earlier in fall following normal summer drought. Mountain and valley quail thrive on lush green native forb leaves (McMillan 1964) during late winter and early spring, and on seeds during late winter spring and early summer, many of which do not exist after medusahead invasion and the formation of its litter mats.

Economic returns from rangelands are reduced by weeds with low forage value that have replaced desirable forage plants.
In central California, the Monterey County tax assessor has recognized the decline in rangeland productivity due to yellow star-thistle and medusahead invasion and has reduced tax assessments on ranches under the provision that tax savings is invested in noxious weed eradication (unpublished memo 2000). More than a 50% reduction on carrying capacity for livestock has been attributed to weed invasion.

Using This Guide

The Guidebook is based on field sampling throughout the rangelands of the Northern Province in Northwestern California as depicted in Figure 1. It contains descriptions of plant communities included in annual grasslands, oak woodlands, meadows, chaparral and selected conifer types. It contains keys to and descriptions of each alliance or series and plant association including vegetation composition, environment, soils, productivity, stand structure and management implications.

Each plant association is assigned an electronic data processing code name (described below) and a regional number (Eco-Code) for identification purposes. The regional identification number correlates the plant association with any type survey work. Examples include ecological unit inventory, wildlife habitat relationships, forest inventory analysis, soil survey, vegetation mapping and old-growth inventory.

Plant Association Nomenclature

Species were assigned to structural categories or strata, ie, tree, shrub, herb, or grass, then given an abbreviated code according to the current version of the Plants Database (USDA, NRCS 2001), based on the "Electronic Data Processing (EDP) Codes For California Wildland Plants" (Reed and others 1963). Used throughout the ecological classification program in California to standardize the identification of plant species and the naming of plant associations, they use the first two letters of the genus and first two letters of the specific epithet (species) plus a numeric code if necessary to distinguish species. Using Oregon white oak as an example, the scientific name *Quercus garryana* would be represented as QUGA4. A full list of the species found in each alliance or series and their EDP codes is found in the Appendix to each vegetation type.

The plant association name is broken down into two parts, the biotic and abiotic. The biotic segment is subdivided by strata, while the abiotic is separated by a double "//". Within the biotic portion of the name a "/" is used to represent a stratum change, while a "-" represents species in the same stratum. Examples of different plant association names include: QUGA4-PISA2/ARPA6-TODI, QUGA4/CECU and CYEC/LAGOP//Rocky. In the first case, QUGA4-PISA2/ARPA6-TODI, two strata are present (tree-tree/shrub-shrub). The second case, QUGA4/CECU, includes only two strata (tree/shrub). The third case, CYEC/LAGOP//Rocky, involves two strata and an abiotic feature (grass/forb//abiotic). The abiotic portion of the name may be added to describe some special feature of the plant association, such as the previous example in which the community is found on very rocky sites.

The plant communities described in this guide fall into two general categories, existing and potential natural vegetation types. At the top of the vegetation hierarchy, existing vegetation types are described as

alliances. An alliance is a physiognomically uniform group of plant associations (Anderson et al. 1998). It is used here to identify the dominant or diagnostic species in an existing vegetation classification. Examples of existing classifications are the annual grasslands and montane meadow vegetation types. Examples of vegetation alliances in the annual grassland type include *Bromus hordeaceus* and *Cynosurus echinatus*.

Potential natural vegetation types describe the biotic community that would be established if all successional sequences of its ecosystem were completed without additional human-caused disturbance under present environmental conditions. At the top of the vegetation hierarchy of potential natural vegetation types is the **series**. A vegetation series is an aggregation of taxonomically related plant associations, which takes the name of the (climatic) climax species that dominate (or have the potential to dominate) the principal vegetation layer in a time frame appropriate to the vegetation or taxonomic group under consideration. Examples of vegetation series in oak woodlands include *Quercus garryana* and *Quercus kelloggii*.

Both potential natural vegetation and existing vegetation types have as their bottom level of the classification hierarchy the plant association (Anderson 1998). In the case of potential natural vegetation the plant association is a community of definite floristic composition and uniform appearance that repeats itself across the landscape and takes the name of the projected climax type. In the case of an existing vegetation classification the definition changes to "takes the name of the dominant or diagnostic species."

The order of species in the plant association name identifies the vegetation series and subseries, respectively. The series is the naturally reproducing species that will dominate a site as the end product of succession. The subseries is the indicator of the position of this ecological type along the environmental gradient within the series. Using the plant associations described above, the *Quercus garryana-Pinus sabiniana/Arctostaphylos patula-Toxicodendron diversilobum* plant association is included within the *Quercus garryana* series. Within this type white oak is the naturally reproducing species that dominates late seral stands. The subseries modifier, *Pinus sabiniana*, indicates the dry end of the white oak series environmental gradient.

Socio-cultural context

One of the dominant human activities in the rangelands of the Northern Province is the gathering of native plants, which sustain socio-cultural, personal and commercial uses. The diverse aboriginal populations in Northwest California use a wide range of native plants to sustain their cultural traditions. Commercial uses of these plants include: saleable food

products, such as mushrooms and herbs used for teas and medicines; floral industry uses, such as ferns, leaves, branches, boughs and cones; wood used for fences and firewood; and grasslands being utilized for livestock feed. Oaks figure prominently in the natural and cultural history within the Northern Province. Acorns from these oaks were a dietary staple of Indians, and the early settlers valued the oaks for fuel, tools, and livestock feed.

Aboriginal Values and Uses:
Aboriginal use of native plant species predates Euro-American uses and management of National Forest lands. Although aboriginal people gather plants from other vegetation series, much of their subsistence comes from plants in the oak woodlands and montane meadows. A significant food supply was provided by grasslands and oak woodlands through the harvest of various grass seeds used for pinol, a sort of mush, and through the harvest and baking of bulbs of lilies, brodiaeas, and camas.

The special purpose plants gathered by Aboriginals include a variety of medicinal plants, as well as plant parts for making utilitarian items, such as basketry, wood tools and items used for ceremonial regalia. Aboriginals are the most experienced users of these plants since they have been gathering these materials in large numbers consistently year after year. Through continuous use, they have developed a keen understanding of the habitats and variousmanagement techniques that can be used to increase the sustainability of the plants that generation to generation. They have used several management strategies including planting, burning, weed control, pruning and thinning to ensure a bountiful harvest. Past management and gathering in some areas has affected current plant composition and diversity.

Widespread Native American burning of tanoak, white oak and black oak landscapes was common in the past. In 1933, a Karuk woman explained her people's use of fire, "Our kind of people never used the plow... All they used to do was to burn the brush at various places, so that some good things will grow up... And sometimes they also burn where the tanoak trees are lest it be brushy where they pick up the acorns. They don't want to burn too hard, they fear the oak trees might burn... Some kinds of trees are better when it is burned off; they come up better once again" (Pavlik et. al 1992). These stands were managed by fire to:

1) enhance the hardwoods, particularly tanoak, also black oak, white oak and live oak by clearing the ground of bug infested duff;

2) enhance the grasses, shrubs and ferns used in basket making, regalia making and tools;

3) create areas, particularly meadows or openings that would attract large game, such as deer and elk, and to produce subsistence plants, such as the brodiaeas and various grasses.

Burning was also done to control insect infestations of the valuable acorn crops. These crops were particularly important for sustaining people through long, cold winters. As Klamath River Jack explained in a 1916 letter to the Fish and Game Commission, "Indians have no medicine to put on all places where bug and worm are, so he burn, every year Indian burn...Fire burn up old acorn that fall on ground. Old acorn on ground have lots worm; no burn old acorn, no burn old bark, old leaves, bugs and worms come more every year. Indian burn every year just same, so keep all ground clean, no bark, no dead leaf, no old wood on ground, no old wood on brush, so no bug can stay to eat leaf and no worm can stay to eat berry and acorn. Not much on ground to make hot fire so never hurt big tree where fire burn" (Blackburn and Anderson 1993).

Contemporary thought is the same; it is believed that the abundance of hardwoods that still exist on the landscape today is there due to the past practice of repeated burning by aboriginals and lightning caused wildfires. Fire suppression efforts by the Forest Service over the last 40 years, with the subsequent duff build-up and the lack of consistent cultural burning, has lead to a decrease in the quality and quantity of native plants. Since approximately 1855 or 1860, Indian harvesters have not been able to maintain the desired habitat for these culturally significant plants because they have been prohibited from using burning and other techniques. In addition, land ownership and development has further impacted these species through timber harvesting and associated road building. Fire suppression has also caused the structure of these hardwood stands to change.

It is believed that many oak stands were more open in the pre-historic past. These open spaces left room for the vigorous growth of young hardwoods as well as light for herbaceous and grass species. The absence or the suppression of fire creates closed canopies that results in a reduction of the numbers and quality of herbs and grasses. Conversely, some herbaceous and shrub species have been affected by an increase in openings due to timber harvesting. For example, clearcut harvests with subsequent burning has resulted in an increase in beargrass in some tanoak and Douglas-fir stands. Beargrass (*Xerophyllum tenax*) has tough, wiry leaves that are used for making baskets and ceremonial dresses. Unfortunately the increase in sunlight in the clearcut unit causes the beargrass leaves to become large and brittle and therefore unusable for dress and basket making. Leaves of beargrass that grow under the shade of a tree canopy are more supple and pliable. Burning beargrass also stimulates new growth that produces more pliable leaves. The cessation of burning may have been detrimental to the production of beargrass leaves

that can be used by aboriginal people.

Hazelnut (*Corylus cornuta* var. *californica*), another important cultural species that has benefited from repeated burning in the past, has only been found in limited numbers in recent years. Its small, straight, pliable stems are a prized and important component of basket weaving. After the burning, it is the one to two-year old slender hazelnut twigs that are collected for use in basketry. Most of the hazelnut stems found today are not suitable for basket making. The lack of useable twigs is due to the decrease in vigorous sprouting that in the past was stimulated by spring fires (Buckman 1964).

For aboriginal people, the importance of managing these types of plant communities was to provide a sustainable, consistent source of food (including wildlife species) that would in turn sustain their cultural traditions. Acorns were and are an important food source and are tied directly to past and present cultural activities. The primary plant food consumed by aboriginal people was the acorn of the tan oak, black oak, Oregon white oak, or canyon live oak. The seed of the acorn was ground into flour that could be eaten during the winter months when fresh food was lacking. Black oak acorns were considered a treat; many styles of preparation and recipes are still used today. A typical family could harvest the crop of an average size black oak in a day and reap about 140 pounds of acorns. This is about one-fifth of what they would consume annually (Heffner 1984).

Oaks were managed extensively by aboriginal people to maintain their lifestyle. This management included ensuring that the acorn crop would continue to provide for their subsistence as well as sustain the wildlife populations that relied on acorns. Many of these wildlife populations were a part of the people's yearly diet. Fire was the main tool used to clear oak stands of disease. It would also create openings and maintain meadows to attract wildlife such as deer. The acorn crop became fairly reliable from year to year due to the management of the oak habitat.
Acorns were second only to salt as an item of trade. Tanoak acorns were particularly valued as a trade item and were often traded by local aboriginal peoples to eastern California tribes. Acorns were as important as the fish resource and, like the ceremonies attached to fisheries, there were ceremonies attached to acorns that still exist today.

Today acorns are still an important food resource, but are gathered in much smaller quantities, except when gathering for ceremonies; far fewer people use acorns as a mainstay in their daily or yearly diet. Acorns today are gathered by the gunny sack-full with the typical family gathering one to three gunny sacks to sustain them for a year. The people strongly believe that even though good quality acorns are sometimes difficult to find today, the interaction between the trees and themselves is an important one in which both are nourished.

Meadows were an important habitat for yearly subsistence for aboriginal peoples. They harvested the resources of the meadows in such a way that the plants continually thrived in the same locations. Harvesting rates were not much in excess of tribal yearly needs with specific harvest methods being utilized to ensure the next year's harvest. Many of these procedures are still practiced today. Their method of harvesting left the vegetative reproductive structures in place; harvesting the most important plants was done on a sustained-yield basis. Bulbs, corms, and tubers of wild onions (*Allium* spp.), blue camas (*Camassia quamash*), yampah (*Perideridia* spp.), lilies (*Lilium* spp.), and wild hyacinth (*Brodiaea* spp.) were harvested carefully, leaving bulblets, cormlets, or tuber fragments behind to ensure a population for the following year. These bulbs, corms, and tubers were historically harvested in great numbers, often being referred to as "Indian potato." When mushrooms were gathered, the stems were left behind so that the mycelia remained intact, thus ensuring future mushroom production. These and other plants are still harvested today in ways that are self-renewing. Areas where favored plants grew became managed gathering sites through these and other methods, such as burning meadows to keep them open from an ever-encroaching overstory (Anderson 1993, Heffner 1984).

A large variety of plants that were gathered by aboriginal people both pre-historically and historically are still harvested today. Some plants are gathered yearly, such as acorns and basketry materials, some are gathered only on special occasions, such as plants used in ceremonies, and some plants are gathered when needed, such as healing plants. There are a number of cultivation and gathering techniques and cultural traditions that are used and passed on to the younger gatherers.

The plants collected are relied upon by the gatherer as 1) an ethnic food that is unavailable on the open market, 2) as medicine to improve or maintain their health, 3) as income through the sale of various native crafts, 4) as an integral item interwoven into religious ceremonies, and 5) the gathering activity itself develops a strong sense of ethnic identity. Family gathering and outings are fused into the cultural process of teaching the young and the transmission of cultural information.

The gathering activity is an integral aspect of the cultural community and is attached to the ethnic self-view. It is interwoven into the cultural community, religious community, and politically in the governing Tribal bodies which provide support for the various forms of gathering in political leadership, philosophy statements and funds. Ultimately, perhaps the most important function of gathering is that it reinforces the bonds of Indian heritage and Tribal identity. It is an ongoing and evolving cultural activity.

Other Values and Uses:
Much of the non-aboriginal subsistence and recreational gathering occurring on the National Forests is done by local residents and by those who live within or near the boundaries of the National Forest. The gathering of plants in this case, is primarily for casual use, although there are some deeply held traditions associated with some uses. Examples of more casual use are fuel wood gathering, Christmas tree cutting, mushroom harvesting and berry picking. The collection of plants for these uses is lower overall when compared to aboriginal gathering. Other than fuel wood gathering, most activities are done intermittently and are carried out by only a few people, usually to support their lifestyle, for crafts or to add to the gatherer's subsistence. Detailed knowledge of exactly what plants and how much is being gathered by the casual user is lacking. According to some of the data that have been collected, this group seems to be able to meet their personal needs and uses. Their gathering does not seem to be oriented towards a particular type of habitat but is associated more with geography, such as near their homes or through historic ties of past family traditions.

Fuel wood collecting is extremely popular and has a high use. Local communities have deeply held values regarding their ability to obtain fuel wood from the National Forests. Often the process of getting the fuel wood is as important as the wood itself.

Commercial Uses:
There is currently no reliable data available to determine the amount of non-timber forest product extraction used for commercial sale. A review of limited permit data over a three year period on the Orleans Ranger District of Six Rivers National Forest showed that Douglas-fir, white fir, incense cedar, Port-Orford cedar, California bay, huckleberry, scotch broom, salal, mushrooms and Christmas trees were harvested for commercial use.

The floral industry harvests boughs, cones, beargrass, hazel, willow, etc. Commercial collectors gather larger quantities of plants than Native American plant collectors. For example, a commercial harvester will collect 1000 pounds of huckleberry and salal, 1000 pounds of white fir and incense cedar boughs, or 3000 pounds of incense cedar, Port-Orford cedar, and red fir boughs or 500 pounds of salal. A Native American plant collector would collect far less than these amounts.

Seven species identified above as commercial harvested plants are significant to Native American plant gatherers for food, medicine and spiritual uses. They are Douglas-fir, white fir, incense cedar, Port-Orford cedar, California bay, huckleberry, salal and mushrooms.

Commercial harvesting is done seasonally and is tied to the weather and crop availability. The commercial plant harvester is not dependent upon a particular watershed for sustenance, nor do they relate to the land historically or culturally. They are more concerned with harvesting the commercially viable plants that are easy to access and are abundant. One of the most important contemporary commercial uses of oaks and oak communities is for livestock grazing. Acorns are highly regarded as a food source for domestic cattle, sheep and pigs. The acorns ripen and fall at the time of the year when quality forage is scarce and are, at the same time, a good source of carbohydrates and crude fiber. Oak leaves are also browsed for their protein and tend to be available during a large portion of the year (Pavlik et. al. 1992).

More important, however, is the fact that oak communities have a productive understory of annual and perennial grasses that forms the basis of the multi-billion dollar livestock industry in California. About 60% of the state's rangelands are oak woodlands that provide meat and dairy products for millions of people (Pavlik et. al. 1992).

Livestock grazing is a double-edged sword. On one hand, a moderate level of grazing acts as a substitute for wildfire, eliminating annual grasses and shrubs that compete with oak seedlings as well as with established trees. But grazing animals can also be detrimental to oaks by consuming acorns, browsing foliage, trampling or eating seedlings, and compacting the soil (Pavlik et. al. 1992).

Silviculture and Silvicultural Systems

Silviculture is the art and science of establishing, tending and protecting forests to produce desired products and conditions. These products and conditions can be wood fiber, erosion protection, wildlife habitat, watershed protection, recreation, scenic values, etc. Silviculture is an important part of this field guide. It is used to determine what treatments, if any, are needed in a forest, so that management objectives can be met, or desired values are maintained and available. Silvicultral implications are supplied for each plant community in the white oak, black oak and blue oak series and are described in the Management Implication Section.

Using the Vegetation Keys

A key to vegetation types in the Northern Province rangelands is provided on pages 37-38 of this introduction.

Keys to vegetation alliance or series are provided in the introduction to each vegetation type. The alliance or series key should be used first. It uses the dominance of key species to determine the existing alliance or potential natural vegetation series. This helps reduce the time required to

key to a plant association. The plant association keys are located in the introduction to each alliance or series. They use the presence of or percent cover of the indicator species to determine plant associations.

Before attempting to use the key, walk around the type of interest and familiarize yourself with the vegetation. The key is structured as a dichotomous choice between statements. To use the key, first read both choices carefully, then choose the one that applies to the type. This process is repeated until you end up at a plant association name. From here proceed to the description of the selected plant association and check the plant association summary table (environment and vegetation) to make sure that you have keyed to the correct vegetation type. If the description does not fit or you become lost in the key, return to the step you felt most secure at and try the key again. If the description still does not fit the type, note the cover and abundance of the dominant species and submit a description and location map to the Province Ecologist.

Key to Rangeland Vegetation Types:

1a. Tree cover < 10%, forb layer dominated by grass, rushes, or sedges..... 2

2a. Rushes and Sedges dominant..... 3

3a. > 5000 ft. elevation.....Montane meadow
3b. < 5000 ft. elevation.....Juncus

2b. Perennial or Annual grasses dominant..... 4

4a. > 40% perennial grasses..... Perennial Grassland
4b. < 40% perennial grasses..... Annual Grassland

1b. Tree cover > 10%, or not as above..... 5

5a. Tree layer dominated by true oaks, white oak, black oak, or blue oak

Douglas-fir absent or in regeneration layer only..... 6

6a. Tree layer dominated by White oak..... White Oak
6b. Tree layer dominated by Black oak..... Black Oak
6c. Tree layer dominated by Blue oak..... Blue Oak

5b. Tree layer dominated by other species or shrub species..... 7

7a. Sites dominated by shrub species..... 8

8a. Dominant shrub species include: *Adenostoma fasciculatum, Aesculus californicus, Arctostaphylos viscida,Ceanothus cuneatus, Cercis occidentalis, Cercocarpus betuloides, Fraxinus dipetala, Garrya fremontii, Heteromeles arbutifolia, Quercus berberidifolia, Quercus durata, Quercus wislizensii, Toxicodendron diversilobum,* .....Chamise, Oak Chaparral

8b. Dominant shrub species include: *Ceanothus cuneatus, Ceanothus velutinus, Chrysolepis sempervirens, Cercis occidentalis, Quercus garryana* ssp. *breweri, Quercus vaccinifolia,* .....Montane Chaparral

7b. Shrub species absent or not as above..... 9
9a. Sites dominatedby conifers..... 10

10a. Gray pine dominant conifer species.....Gray pine
10b. Gray pine absent or not as above..... 11

11a. Knobcone pine dominant conifer species.....Knobcone pine
11b. Knobcone pine absent or not as above..... 12

12a. Ponderosa pine dominant conifer species.....Ponderosa pine
12b. Ponderosa pine absent or not as above.....or

9b. Conifers absent or not as above..... check vegetation community (i.e., annual grassland, oak woodland, etc.), note dominant species and submit with location map to Province Ecologist.

Plant Association Descriptions

Once a plant association is identified and verified, the plant association description should be reviewed. The plant association description contains the following categories and types of information: plant association name, ecocode (for use in identifying the plant association during inventories), the wildlife habitat relationship vegetation type, a photograph of the community, the average species richness and Shannon Index, and summary tables of ecological status, species composition, environment and soils. A description of the physical and biological environment, including sections on distribution/setting, soil summary, vegetation summary, species richness, ecological status, management emphasis rating, site potential, closely related types, noxious weeds and management implications is included (described below). Drawings of the primary indicator species and a brief write-up about what they indicate are provided. Summary tables in the appendices compare plant communities by the various categories described. Terms used are defined in the glossary.

Characteristic cover is used in this document rather than average cover. Characteristic cover is defined as the percent cover one could expect to find in a plant association if the species were present in this type. It is the average cover of stands containing the species. For example plant association X includes ten plot samples; on five of these plots species Y had 10% cover. Therefore, the characteristic cover would be 10%. Characteristic cover (mean cover) is displayed along with the range of cover of the species in all plots, and constancy. Constancy is the percent of times a species was found to occur in a plant association among the plots sampled. Using the same example as above, species Y would have a constancy of 50%; that is, it occurred in 50% of the plots sampled.

Distribution/Environment

The distribution is defined by its membership in sections of the National Hierarchy of Ecological Units (McNab and Avers 1994) and by National Forest Ranger District. The physical environment is defined by distance to the Pacific Ocean, elevation, mean annual precipitation, percent slope class, aspect (Table 3), radiation index, slope position, horizontal and vertical micro-relief. Sites with low radiation index are considered cool, while those with high radiation index are generally warm unless influenced by topographic shading (Table 4).

Table 3. Definitions of slope classes.

Slope Classes	Lower Percent	Upper Percent
Nearly level	0	3
Gently sloping	1	8
Strongly sloping	4	16
Moderately steep	10	30
Steep	20	60
Very steep	>45	

Table 4. Definitions of radiation index classes.

Radiation Index Classes	Lower Index	Upper Index
Cool	.200	.400
Moderate	.401	.500
Warm	.501	.600

Comparisons of each plant association by environment variables are contained in the appendices for each vegetation type.

Soil Summary

Soils are described by temperature regime, drainage class, parent material origin, rock type, litter layer and thickness, bare ground, surface gravel and rock, soil depth, annual water-holding capacity calculated to 20 inches,

A horizon thickness, A horizon coarse fragment percent, A horizon texture and A horizon color. Other special features of the soil are described, such as the presence of an argillic or cambic horizon. Soils were classified to Order, Subgroup or Family. Each plant association is compared by soil variables in the appendices for each vegetation type.

Vegetation Summary
Vegetation is described by range of cover and total percent cover for each layer including overstory and understory trees, shrubs, forbs and grasses. Tree and shrub species with greater than 20% constancy, and forb and grass/grasslike species with greater than 30% constancy are listed for each plant association. All plants were identified to species where possible. Species nomenclature follows Hickman (1993) and common names used follow the Plants Database (USDA Soil Cons. Serv. 1999). A complete list of species for each vegetation type encountered during this study is included in the appendices for each vegetation type. A vegetation summary by plant association is also included in the Appendices for each type..

Species Richness
Mean species richness and Shannon diversity index are enumerated and described. Species richness is also presented for native and non-native species and for grasses and forbs.

Ecological Status
Mean cover of grasses, forbs,annual and perennial species is presented for each community. Long-term and short-term successional status is described by the amount of plant cover in each of three seral stages (early, mid and late).

Management Emphasis Rating
The management emphasis rating for each community is described and the percent of plots in each MER category is presented.

Site Potential
Site potential is described by the perennial and annual native species that occupy these sites and are likely candidates for improved ecological status.

Closely Related Types
Plant associations that appear to be closely related to the described plant association are listed and compared by environment.

Noxious Weeds
Noxious weeds identified in each plant association are listed along with their constancy and percent cover.

Stand Structure Variables
Stand structure is described for forested plant associations and includes mean values for stand age, trees/acre by diameter class, layers, height, conifer and hardwood cubic volume and basal area, Dunning site class (base age 300 years)(Dunning 1942) and stand density index. Stand structure is compared by plant association in Appendix **??**

Management Implications
This section describes general management implications and guidelines. The emphasis in this section is prevention of further degradation of the soil, improvement of ecological status and reduction of noxious weed cover. Specific management implications are included for each plant association to provide predictive information about the response of plant associations to treatment and any special problems that may be encountered. Special considerations are described that list species known to occur in a plant association that may have potential for management problems.. A list of management implication categories is included in Table 5. This is followed by a description of each category.

Management implications were derived from a variety of sources. They included; literature, plot sampling, professional experience and ecology plot data queries.

Table 5. List of management implication categories reviewed for each plant association.

Soils
- temperature regime
- drainage
- bare ground
- surface gravel and rock %
- depth
- parent material
- color
- coarse fragment content
- diagnostic horizons
Noxious weeds
Balance of native and exotic species
Regeneration
Animal Damage Control Problems
Stockability
Species Considerations
Insects and Disease
Plant Uses
Fire Suppression
Prescribed Fire

Regeneration: Discussions on the appropriateness of artificial versus natural regeneration and plantability.

Animal Damage Control Problems: Discusses any animals that may potentially impact on various plant associations; i.e., gophers, deer.

Stockability: How plant associations relate to regional stocking levels (minimum) or could deviate from Regional guides.

Species considerations: Species listed in this section are either important to or undesirable in a stand. Some of these species should be maintained in a stand because they have important wildlife, cultural or genetic value. Examples of valuable tree species include Pacific yew, black oak and white oak.

Plant uses: species listed in this section have been historically or are currently gathered to sustain cultural values, or are collected by commercial harvesters. Consideration should be given to these species when management activities are planned. Two of these species, California hazelnut and beargrass, provide basket-making material for Native Americans. The health and vigor of both of these species is dependent upon burning. Prescribed burning could be considered when either of these species is present in a stand. Species with historic, current or commercial non-timber uses are listed in the appendices for each vegetation type.

Insects and disease: Insect or disease problems of concern in any of the plant associations. If the potential for insects or disease is present, what is the risk rating?

Fire Management has only two options to use fire to enhance the ecosystem, (1) by fire suppression strategies and (2) by prescribed fire. Other forest management practices may be used to reduce hazardous fuel accumulations, but the absence of fire may alter the ecosystem's adaptation to fire, endangering species survivability.

Fire Suppression and Prescribed fire: The three suppression strategies--confine, contain and control--are described below:

> Confine: To restrict the fire within determined boundaries established either prior to or during the fire.
>
> Contain: To take suppression action, as needed, which can reasonably be expected to check the fire's spread under prevailing conditions.

Control: To complete control lines around a fire, spot fires, and any interior islands to be saved, burn out any unburned area adjacent to the fire side of the control lines; and cool down all hot spots that pose immediate threats to the control line, until they can reasonably be expected to hold under foreseeable conditions.

Historically, suppression strategies have focused on controlling all fires. Recently tactics, known as Minimum Impact Suppression Tactics or "light hand on the land," have been adopted to meet the control suppression objective while trying to lessen adverse impacts to the environment from suppression operations. These have been designated in the Fire Management's Operation Guide primarily in special interest areas: wilderness, botanical areas, research natural areas and Indian cultural resource sites. These tactics limit use of bulldozers, aircraft, and traditional aerial retardants, and in some areas, power tools.

Many plant associations would benefit from suppression strategies other than control. Some associations are fire tolerant and/or fire dependent. Others experience greater adverse impacts from line construction than from the fire itself. Suppression alternatives or recommendations will be made for each plant association.

Prescribed Fire: Prescribed fire has had limited implementation. Douglas-fir and tanoak plant associations lend themselves to enhancement from fire disturbance under various conditions and fire behavior, as do late seral reserves (LSRs) if we are to maintain stand diversity and regeneration within them.

Use of prescribed fire in ecological restoration and vegetation management should not be entirely based on historical "natural" occurrence of fire, but considered in conjunction with the desired fire effects. Burning for burning's sake is not the answer to years of fire suppression. Using fire to manage plant associations provides the opportunity to understand their relationship with and adaptation to fire and to define the ecological effects desired, not just the conditions under which a fire will spread and can be controlled. By defining the desired ecological condition, objectives can better be evaluated, as well as the success of the burn. In turn, a range of prescriptions may be used to obtain a landscape diversity that enhances plant diversity.

Many sensitive species, both plants and animals, can experience adverse affects from disturbance caused by moderate to high fire behavior. Using prescribed fire under proper weather conditions and seasons of the year to benefit the plant association has been overlooked in the past or been limited by single animal species. As managers we need to look at the total plant association and the need to reintroduce fire to sustain the total

ecosystem, realizing that fire's negative impacts will not be an annual event, but short term disturbance. This must be done in a programmatic manner which treats areas on the basis of priorities derived from ecosystem and specific resourcemanagement needs, and to an extent aimed at successfully protecting and enhancing the acres for which we are responsible.

Total ecosystem management is difficult with existing conflicting resource management objectives (eg. wildlife, soils, timber) and legislation (eg. Clean Air Act related to smoke emissions and smoke dispersal). Total protection for one species may not be to the benefit of all associated species. Prescribed fire and fire's ecological effects need to be considered as integral tools in ecosystem management.

ANNUAL GRASSLANDS

INTRODUCTION

The grasslands of California were first described by Heady (1958) simply as California annual grasslands. Later, the coastal portions were described by Heady et al. (1977) and Bartolome (1987) as Coastal Prairie. The inland portions of these grasslands surrounding the Central Valley were described as Valley Grassland (Bartolome and Brown 1994). The grasslands of the Northern Province fall geographically between the Coastal Prairie and the Valley Grasslands of the Central Valley and hence contain species common to both rangeland cover types. They were found in small patches averaging 10.5 acres/patch. Ninety-seven percent of the patches were less than 50 acres in size. Seventy-eight percent of these were less than 10 acres in size. These small patches were nested among a mosaic of oak woodlands and conifer forests.

The extent of annual grasslands in the Northern Province was initially estimated using the mapping effort completed by the USFS Remote Sensing Laboratory (RSL). They identified 387,487 acres of annual grasslands distributed throughout the Province including 67,972 acres on the Six Rivers National Forest. This estimate appears high in light of the comparison of fine scale mapping efforts on the Six Rivers National Forest where total annual grassland extent was mapped as 16,726 acres. The RSL mapping effort used the CALVEG classification for California. It identified one annual grassland vegetation type described as annual grassland-forb within the North Coast and Montane Ecological Province (Parker and Matyas 1979).

Plot-based vegetation classification descriptions in the Northern Province were limited, with the highest number from the Bald Hills of Redwood National Park. These studies mainly identified annual grasslands dominated by non-native annual grasses. The earliest descriptions of Northern California rangelands were completed by Davy (1902). He described forage plants and rangeland conditions throughout the northern part of the state. Heady et al. (1977) described species composition on the prairie balds of Humboldt County. Hektner et al. (1983), in a study in the Bald Hills, identified *Cynosurus echinatus, Aira caryophyllea and Danthonia californica* as dominant species in their sample area. Sugihara et al. (1986) described one type, *Arrhenatherum elatius-Sherardia,* from glades interspersed between oak woodlands in the Bald Hills.

Grenier (1989), also working in the Bald Hills of Redwood National Park, concluded that well-defined vegetation types did not exist in the two prairies. The first author reviewed Grenier's TWINSPAN output and concluded that at least ten associations were easily recognized. These associations included *Carex tumulicola-Arrhenatherum elatius-Holcus lanatus, Arrhenatherum elatius-Holcus lanatus, Bromus hordeaceus-Cynosurus echinatus-Anthoxanthum aristatum, Anthoxanthum aristatum/Lotus micranthus, Dactylis glomerata-Holcus lanatus, Poa pratensis-Carex tumulicola, Arrhenatherum elatius/Plantago lanceolata, Arrhenatherum*

elatius-Lolium perenne/Geranium dissectum, Bromus hordeaceus-Cynosurus echinatus-Bromus diandrus and *Bromus hordeaceus-Cynosurus echinatus/Rumex acetosella* associations. Arguello (1994) also worked in the Bald Hills evaluating burning effects on sites dominated by *Arrhenatherum elatius* and *Danthonia californica.* Jimerson et al. (1988) described two vegetation associations, *Arrhenatherum elatius-Bromus hordeaceus*/Mesic Grassland and *Cynosurus echinatus-Bromus rigidus*/ Dry Grassland, from the Board Camp Mountain area of Humboldt County. Leitner and Leitner (1988) identified and mapped one annual grassland community containing Bromus *hordeaceus, Bromus diandrus, Avena barbata* and *Cynosurus echinatus* in the Soldier Basin Research Natural Area of Trinity County. Stuart et al. (1996) described one annual grassland plant association, *Bromus tectorum-Poa pratensis*, from Castle Crags State Park.

Distribution

The annual grasslands of the Northern Province described in this study were found primarily on the Mendocino and Six Rivers National Forests in the Northern California Coast Ranges Section (M261B) of the National Hierarchy of Ecological Units (USDA 1994) (fig. 1). The Northern Province annual grasslands were found within Humboldt, Trinity, Mendocino, Tehama, Glenn, Colusa and Lake Counties. The annual grassland classification was constructed from 201 plots dispersed throughout the federal lands of this area. As more information from other federal lands becomes available the classification will be expanded.

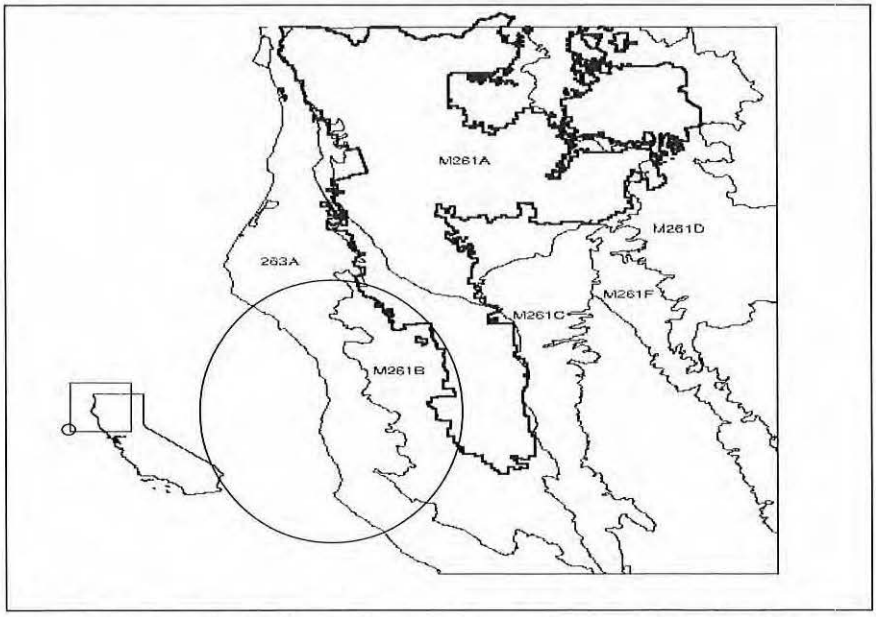


Figure 1. Map of the Northern California Coast Ranges Section (M261B) of the National Hierarchy of Ecological Units showing the general distribution of annual grasslands in the Northern Province (within circle).

In terms of National Forests and Ranger Districts, most annual grassland plots were sampled on the Six Rivers National Forest, Mad River and Lower Trinity Ranger Districts. Second in plot coverage was the Mendocino National Forest, Covelo, Upper Lake and Grindstone Ranger Districts.

Environment

The annual grassland vegetation type was found between 26.8 and 62.2 miles inland from the Pacific Ocean. Elevation here ranged from 1840 to 4480 feet, with mean annual precipitation ranging from 45 to 75 inches. Aspects were primarily southwest and southeast with a limited number of plots facing east and west. North-facing slopes were generally occupied by woody plant communities. Slopes were generally moderate to steep and fell into the following slope percent classes: < 21% slope (37%), 21-40% slope (42%), 41-60% slope (20%) and > 60% slope (1%). Slope micro-positions were primarily upper 1/3 (43%) and middle 1/3 slopes (37%), with lower 1/3 slopes accounting for 14% of the sample plots and ridgetops for 6%. Horizontal micro-relief (slope shape) was linear (45%), undulating (21%), convex (21%) and concave (13%). Vertical micro-relief was mainly linear (56%) and undulating (25%), with low frequencies of convex (9%) and concave (10%) slope shapes.

Three environment factors were used in part to determine the management emphasis rating described later. These factors were bare ground percent, surface gravel and rock percent and litter cover percent. Bare ground in the annual grassland type was variable. Sixty percent of the plots had < 10% bare ground, while 26% had from 10-20% bare ground and 14% had > 20% bare ground. Surface gravel and rock were low with 70% of the plots with < 10%, 21% between 10-20% and 10% with > 20% surface gravel and rock. Surface litter (dead leaves and twigs in various states of decay) was relatively low in the annual grassland type. Over 70% of the plots had < 20% surface litter, 12% of the plots had between 20% and 50% surface litter and 18% had > 50% surface litter.

Soils

Eighty percent of the soils in the annual grassland type were included within the thermic (mean soil temperature 15-22° C) and mesic (mean soil temperature 8-15° C) soil temperature regimes. Soil depth frequency was 60% deep (> 40 inches), 28% moderately deep (20-40 inches) and 12% shallow (< 20 inches). Soils were 68% well drained, 17% moderately well drained and 10% somewhat excessively well drained. They formed in colluvium and residuum from sandstone rocks, such as graywacke, argillite, chert, shale and siltstone.

The A horizons were 4% thin (0-3 inches), 44% moderately thick (4-9 inches) and 52% thick (10+ inches). Eighty-eight percent of the A horizons contained less than 35% coarse fragments (non-skeletal) while 12% of the samples had coarse fragment content greater than 35% (skeletal). Soil textures were loams (18%), gravelly loams (39%), gravelly sandy loams (2%), gravelly clay loams (8%), clay loams (7%), silt loams (4%), gravelly

silt loams (3%) and very gravelly loams (3%). A horizon color reflects the organic material included in these soils. They were primarily 10YR 3/2 (very dark grayish brown), 10YR 3/3 (dark brown), 10YR 3/1 (very dark gray) and 2.5Y 3/2 (very dark grayish brown). A horizon soil pH was 32% moderately acid (5.6-6.0), 42% slightly acid (5.6-6.5) and 26% neutral (6.6-7.8). A horizon clay content was generally moderate. Eight percent of the plots had ≤ 10% clay content, 41% had between 11 and 20% clay content, 48% had between 21 and 30% claycontent and 3% had > 30% clay content.

The subsoil coarse fragment contents were 63% non-skeletal and 37% skeletal. Subsurface soil textures were primarily gravelly clay loam (24%) and clay loams (21%). Other textures included very gravelly loams (3%), gravelly loams (3%), cobbly silt loams (4%), gravelly sandy clay loams (3%), very gravelly clay loam (3%), very gravelly clay (4%), gravelly clay (3%), clay (4%), silty clay loams (3%), extremely stoney loams (3%) and extremely gravelly clay loams (3%). Subsurface soil color also reflects the organic material included, but they tend toward more gray colors that indicate reducing conditions. They were primarily 10YR 4/2 (dark grayish brown), 10YR 4/3 (dark brown), 10YR 3/2 (very dark grayish brown), 10YR 3/1 (very dark gray), 2.5Y 3/2 (very dark grayish brown) and 2.5Y 4/2 (dark grayish brown). Subsurface pH was 18% moderately acid (5.6-6.0), 41% slightly acid (5.6-6.5), 36% neutral (6.6-7.8) and 5% slightly alkaline (7.8+). Subsurface clay content was generally high. Two percent of the plots had ≤ 10% clay content, 8% had between 11 and 20% clay content, 37% had between 21 and 30% clay content, 40% had between 31 and 40% clay content and 13% had > 40% clay content.

Soil family classification for the annual grassland type is displayed in Table AG-1 (p. 7). Many of these annual grassland sites exist on soils with typical grassland characteristics such as mollic epipedons, dark surface horizons and high-incorporated organic material. This indicates long-term occupancy by grasses and grass-like species. The orders Mollisols (37%) and Inceptisols (31%) dominate the annual grassland types followed by Alfisols (22%) and Entisols (10%). A brief general description of each soil order is shown below, along with its great groups. In addition, a rating of sensitivity to compaction from cattle hoof trampling and other management problems that could be expected are included.

Mollisols:
These soils are mainly found in the relatively dry areas of the Northern Province that support grasslands. They are very dark colored, base- rich, with a relatively thick, dark-colored, humus-rich surface horizon, as a result of the breakdown of organic matter (mollic epipedon), and an illuvial clay layer that can restrict grass root penetration (argillic horizon). They have mostly developed under a grass vegetation layer (Soil Survey Staff 1975).

The great groups Argixerolls, Haploxerolls and Endoaquolls dominate the order Mollisols in the annual grasslands. They were mainly classified as fine or fine-loamy, thermic, Typic, Ultic or Pachic Argixerolls; loamy-skeletal

or fine-loamy or fine, thermic or mesic, Typic, Ultic or Pachic Haploxerolls; and loamy-skeletal or fine-loamy, thermic, Typic Endoaquolls. All three families are described as having a low sensitivity to compaction due to the amount of organic matter and the resilience of this soil order.

Inceptisols:
These soils are generally found in the northern portion of the Northern California Coast Ranges Section (M261B) where moisture is higher. They support a variety of vegetation types including grasslands, chaparral, oak woodlands and conifer forests. They are characterized as weakly developed with little profile development, the diagnostic features are either a cambic horizon or umbric epipedon. Cambic horizons have often lost base compounds and are found at the surface of some truncated soils (Soil Survey Staff 1975).

The great groups Xerochrepts and Xerumbrepts dominate the order Inceptisols in the annual grasslands. They were mainly classified as loamy-skeletal or fine-loamy, thermic, Dystric, Typic or Vertic Xerochrepts; or fine-loamy or loamy-skeletal, thermic, Pachic or Typic Xerumbrepts. The fine-loamy, thermic, Dystric, Typic or Vertic Xerochrepts are described as having a high sensitivity to compaction, while the loamy-skeletal, Xerochrepts are rated as moderately sensitive to compaction. The great group Xerumbrepts are all described as having a low sensitivity to compaction.

Alfisols:
These soils are generally found between the dry Mollisol grassland band and moist Inceptisol band along an elevation gradient. In the Northern Province, they support a variety of vegetation types including grasslands, chaparral, oak woodlands and conifer forests. Alfisols generally have both an ochric epipedon and an argillic horizon (Soil Survey Staff 1975).

The Haploxeralfs were the only great group identified in the order Alfisols. They were mainly classified as fine-loamy, loamy-skeletal, fine or fine-silty, thermic or mesic, Mollic, Ultic or Typic Haploxeralfs. The fine-loamy, fine and fine-silty textured, Ultic or Typic Haploxeralfs were rated as having a high sensitivity to compaction. The loamy-skeletal textured Haploxeralfs as well as the Mollic Haploxeralfs were rated as having a low sensitivity to compaction.

Entisols:
These are mineral soils that are poorly developed with no evidence of diagnostic horizons (Soil Survey Staff 1975). They generally occur on relatively steep and unstable surfaces that tend to inhibit horizon development.

The Xerorthents were the only great group identified in the order Entisols. They were mainly classified as fine-loamy and loamy-skeletal, thermic or mesic, lithic, Dystric or Typic Xerorthents. All of the Xerorthents except the

fine-loamy, thermic, lithic Xerorthents, which was rated high, were rated as having a moderate sensitivity to compaction. In addition, these soils were either lithic or skeletal which further decreases the area available for water storage and hence plant growth.

Despite the dominance of deep soils with low coarse fragment content, annual grassland soils were relatively dry. This is a result of their southerly aspects, southerly position along the north/south gradient of the Northern Province, warmer temperatures, lower rainfall, upper and middle 1/3 exposed slope positions, generally coarse textured soils and occasional argillic soil horizons and their influence on rooting depth.

Table AG-1. Soil families and percent occurrence in the annual grassland vegetation type.

Texture	Temperature	Great Group	Percent
loamy-skeletal/coarse-loamy	thermic/mesic/lithic	Dystric/Typic Xerorthents	10
fine/fine-loamy/fine-silty/coarse-loamy/coarse-skeletal	thermic/mesic	Typic/Ultic/Pachic Argixerolls	24
fine-loamy/loamy-skeletal	thermic	Pachic/Typic Xerumbrepts	19
fine-loamy/loamy-skeletal	thermic/lithic	Dystric/Typic/Vertic Xerochrepts	12
fine-loamy/loamy-skeletal/fine/fine-silty	thermic/mesic	Mollic/Ultic/Typic Haploxeralfs	22
loamy-skeletal/fine-loamy/fine	thermic/mesic	Typic/Ultic/Pachic Haploxerolls	12
fine-loamy/loamy-skeletal	thermic/mesic	Typic Endoaquolls	1

Vegetation

The Northern Province annual grasslands were primarily composed of non-native annual grasses (Table AG-2), whose constancy and cover far exceeded that of all other categories (57% mean cover). They were dominated by *Bromus hordeaceus*, *Aira caryophyllea*, *Cynosurus echinatus*, *Bromus tectorum*, *Bromus diandrus*, *Avena barbata, Taeniatherum caput-medusae*, *Avena fatua, Briza minor and Arrhenatherum elatius.* The annual native grass category was of very low cover (< 1% mean cover). It was represented by *Vulpia microstachys.* The perennial non-native grass category was represented by only one species with high cover, *Arrhenatherum elatius* (29%). This species was found on only 12% of the annual grassland plots. The remaining perennial non-native grasses had low cover (6% mean cover) and were represented by *Poa pratensis* and other *Poa* species. The perennial native grass and grasslike plant category was also of low cover (5% mean cover). It was represented by *Elymus glaucus, Danthonia californica*, *Juncus* spp., *Achnatherum lemmonii, Bromus carinatus* and *Poa secunda.* These are likely the species that dominated many of these sites prior to the introduction of the aggressive

non-native species that now dominate. Species lists and comparison tables by plant association are contained in Appendices AG-1 and AG-2.

Table AG-2. Primary grass species and grass relatives identified in the Northern Province annual grasslands with constancy, mean cover, life cycle and origin.

Species	Constancy	% Mean Cover	Life Cycle	Origin	R5 Seral Status
Aira caryophyllea	70	8	annual	non-native	Early
Arrhenatherum elatius	12	29	perennial	non-native	Early
Avena barbata	37	5	annual	non-native	Early
Avena fatua	22	9	annual	non-native	Early
Bromus carinatus	14	5	perennial	native	Mid
Bromus madritensis ssp.*rubens*	12	6	annual	non-native	Early
Briza minor	18	2	annual	non-native	Early
Bromus hordeaceus	96	17	annual	non-native	Early
Bromus diandrus	41	6	annual	non-native	Early
Bromus tectorum	46	8	annual	non-native	Early
Cynosurus echinatus	74	21	annual	non-native	Early
Danthonia californica	15	5	perennial	native	Mid
Taeniatherum caput-medusae	25	14	annual	non-native	Early
Elymus glaucus	21	3	perennial	native	Mid
Hordeum marinum ssp. *guuson.*	11	20	annual	non-native	Early
Juncus sp.	16	5	perennial	native	Late
Luzula comosa	9	1	perennial	native	Late
Poa spp.	13	5	perennial	both	Early
Poa pratensis	11	2	perennial	non-native	Mid
Poa secunda	9	2	perennial	native	Late
Achnatherum lemmonii	14	4	perennial	native	Late
Vulpia microstachys	8	4	annual	native	Early
Vulpia myuros	10	2	annual	non-native	Early

The forb and grass layers differed from one another based on the shift of dominance from non-native grasses to native forbs. Highest cover in the forb layer was in the annual native forb category (24% mean cover) (Table AG-3). The annual native forb category was represented by *Agoseris heterophylla, Clarkia* spp., *Daucus pusillus, Hemizonia congesta ssp. luzulaefolia, Lagophylla* sp., *Lotus humistratus, Madia elegans, Trifolium bifidum* and *Trifolium tridentatum*. The forb annual non-native category had 7% mean cover. It was represented by *Cerastium glomeratum, Centaurea solstitialis, Erodium cicutarium, Geranium dissectum, Torilis arvensis* and *Trifolium* spp. The perennial native forb category had a mean cover of 9%. It was represented by *Achillea millefolium, Chlorogalum pomeridianum, Dichelostemma capitatum* ssp. *capitatum, Lomatium dissectum, Ranunculus occidentalis* and *Vicia americana*. The perennial non-native forb category had a low mean cover of 4%. It included *Hypericum perforatum, Rumex acetosella* and *Taraxacum officinale* (Appendix AG-I).

Table AG-3. Primary forb species identified in the Northern Province annual grasslands with constancy, mean cover, life cycle and origin.

Species	Constancy	% Mean Cover	Life Cycle	Origin	R5 Seral Status
Achillea millefolium	22	3	perennial	native	Early
Agoseris heterophylla	15	3	annual	native	Mid
Castilleja attenuata	10	1	annual	native	
Cerastium glomeratum	37	2	annual	non-native	Mid
Centaurea solstitialis	9	15	annual	non-native	Early
Chlorogalum pomeridianum	19	1	perennial	native	Late
Clarkia sp.	42	3	annual	native	Early
Clarkia purpurea	15	4	annual	native	Early
Cryptantha intermedia	16	1	annual	native	Early
Daucus pusillus	14	5	annual	native	Early
Dichelostemma capitatum ssp. *c.*	59	1	perennial	native	Late
Erodium botrys	32	4	annual	non-native	Early
Erodium cicutarium	18	5	annual	non-native	Early
Eschscholzia californica	10	1	annual	native	Late
Galium parisiense	12	1	annual	non-native	Mid
Geranium dissectum	16	4	annual	non-native	Mid
Hemizonia congesta ssp. *luzulaefolia*	19	11	annual	native	Early
Hypericum perforatum	15	1	perennial	non-native	Early
Lagophylla sp.	6	7	annual	native	Early
Linum bienne	10	2	perennial	non-native	Mid
Linanthus bicolor	17	3	annual	native	Early
Limnanthes douglasii	14	14	annual	native	Late
Lomatium dissectum	22	2	perennial	native	Mid
Lotus humistratus	26	4	annual	native	Early
Lotus micranthus	23	8	annual	native	Early
Lupinus bicolor	13	1	annual	native	Early
Lupinus sp.	14	3	perennial	native	Mid
Madia sp.	28	4	annual	native	Early
Madia elegans	11	13	annual	native	Early
Plantago lanceolata	10	2	perennial	non-native	Early
Ranunculus occidentalis	24	3	perennial	native	Early
Rumex acetosella	27	4	perennial	non-native	Early
Sanicula bipinnatifida	19	2	perennial	native	Mid
Taraxacum officinale	22	3	perennial	non-native	Early
Torilis arvensis	19	3	annual	non-native	Early
Trifolium albopurpureum	11	4	annual	native	Early
Trifolium bifidum	21	7	annual	native	Early
Trifolium sp.	47	3	annual	both	Early
Trifolium wildenovii	33	4	annual	native	Mid
Veronica arvensis	10	1	annual	non-native	Early
Vicia americana	22	2	perennial	native	Early

Indicator Species

Most annual grasslands in California, including the herbaceous understory in oak woodlands, are dominated by introduced annual grasses. These communities also support many introduced forbs although native forbs are generally much more common than non-natives. Most non-native annual grasses and forbs have become naturalized, and without extraordinary restoration effort will remain dominant members of these communities. This has resulted in alteration of natural succession processes for these communities since late-seral perennial grasses normally cannot out-compete the prolific annuals in order to achieve late-seral stage conditions. However, within many communities of introduced annual grasses and forbs, predictable replacement seral species, or "quasi-succession," does occur. Strategies to increase abundance of late-seral natives is a worthy goal, but expecting dominance is unrealistic in most situations. In trying to meet this goal it is useful to accurately interpret vegetation changes, including replacement species, within communities of introduced annual grasses and forbs.

A large volume of reference exists justifying changes in plant community composition and bare soil exposure as indicators of grazing impacts (NRC 1994 and Ratliff 1985). We will not review that literature here except to say that excessive defoliation and trampling, both temporally and spatially, can selectively reduce the growth capacity of individual plant species, thereby reducing their fitness and survival and leading to changes in plant community composition. On the other hand, lack of herbivore (wildlife and livestock) grazing in grazing-adapted ecosystems such as grasslands and meadows can lead to unnatural plant compositions, especially in those subjected to exotic plant invasion or high litter accumulation. Over time, the plant community composition reflects grazing effects. As soil is the ultimate resource supporting terrestrial biota, changes in soil exposure to erosion indicates potential risk for soil loss and therefore loss of sustainability. Thus, reduction in bare soil on range allotments is a second important indicator of good stewardship.

Annual Grassland Indicator Grasses:

Much is known about some grass and grasslike species, which indicate quite different environmental and grazing-impacted conditions. Much of this species-specific information was developed from the collective experience of range scientists, specialists and ecologists, and from reference material (USDA 1937, Dayton 1960, Hermann 1966, Crampton 1974, Stechman 1986). A discussion of a limited number of grasses, grasslike species and forbs is presented in the introduction to each of the major vegetation types described in this guide. In the case of annual grasslands, the grass species with high frequency of occurrence (Table AG-2) are described below by environment and indicator value.

***Achnatherum lemmonii*—Lemmon's Needlegrass:** This native, perennial grass is found intermixed with annual grasses on low to high elevation sites. It often forms open stands with high bare ground, particularly on upper elevation sites.

***Aira caryophyllea*—Silver Hairgrass:** This introduced, annual species is an indicator of dry, degraded conditions. It is most often found on upper 1/3 slopes or spur ridges with convex slope shapes. Where it has high cover it indicates over-grazing, disturbed or infertile soils, compaction and low amounts of litter. These conditions are not conducive to the establishment of perennial grasses, given their weak seedling vigor.

***Arrhenatherum elatius*—Tall Oatgrass:** This perennial species was introduced into the eastern U. S. as early as 1884. It is palatable to all classes of livestock, both while green and as winter forage. It greens up earlier in spring and remains green longer into late fall than most native grasses. While it is palatable to livestock, they will not seek it out as a primary forage plant when other species are available. It grows on a wide range of soil textures and can be robust on productive sites, exceeding seven feet in height. It is one of the most drought-resistant grasses due to its deep root system.

***Avena fatua*—Wild Oat:** This introduced species typically grows on open slopes and often dominates the grassland. It was brought to California very early after settlement at the time the missions were established. It tends to simulate a climax type but with close grazing it is replaced with less palatable bromes and fescues. *Avena barbata* behaves similarly. Wild oat is one of the most responsive annual grasses to high soil fertility and moist, but not wet soils. It can exceed eight feet in height under unusually prime conditions. It often shades out shorter species and its litter keeps soils relatively cool, inhibiting heat-triggered germination of species such as *Erodium botrys* and *E. brachycarpum.*

***Avena barbata*—Slender Oat:** This is an introduced annual, naturalized on low elevation sites. It is tolerant of a variety of soils and is a preferred forage species, particularly in spring.

***Bromus carinatus*—California Brome:** This native perennial grass is typically found in large moist to dry meadows and forest openings and indicates mid seral upland conditions. Seed of many local ecotypes of *Bromus carinatus* are now commercially available for restoration projects. This is a short-lived bunchgrass on moist sites.

***Bromus* spp.--Bromes:** All of the annual bromegrasses are invaders, and including *Bromus tectorum* (cheatgrass), *B. hordeaceus* (formerly B.

mollis), B. diandrus, and *B. madritensis* ssp. *rubens*, are invaders of montane meadows and sagebrush-steppe ranges and indicate varying degrees of disturbance. Given the rather complete transformation of the herbaceous component of foothill grassland/oak woodland communities, the annual bromes listed above are now considered 'resident annuals' and permanent members of what is now called the California annual grassland. The greatest threat to sustainability of these grasslands is exotic weed invasion, especially by yellow star-thistle (*Centaurea solstitialis). Bromus hordeaceus* is very palatable to livestock and cures well, maintaining relatively high nutrient content as dry standing forage.

***Bromus madritensis* ssp. *rubens*—Red Brome:** This introduced annual commonly grows on shallow dry soils or poor-textured clayey soils on south-facing slopes. It often grows with *Bromus hordeaceus* or *Bromus tectorum*, but apparently is more sensitive than either of them to plant competition. Red brome is shade intolerant and shallow-rooted), allelopathic substances and grazing patterns. It is adapted to, and competitive in, disturbed sites but is not considered a problem in undisturbed areas (bare soil is a requirement). Grazing and burning may increase its abundance by providing bare soil and improved light conditions.

***Briza minor*—Little Quaking Grass:** This introduced annual is now naturalized throughout most of California on lower elevation sites and areas with high rainfall. It is often used in dried flower bouquets and as an ornamental. Forage value is low after flowering. This grass indicates the greatest degree of disturbance, including trampling and compaction effects of livestock, with virtually no soil surface litter accumulation. These conditions are not conducive to the establishment of perennial grasses given their weak seedling vigor.

***Cynosurus echinatus*—Hedgehog Dogtail:** This is an introduced annual, naturalized on low elevation sites. It is of little value for forage and its increasing cover indicates range deterioration. It matures later than most annuals, therefore early heavy grazing allows it to easily compete with earlier-flowering grasses and produce a heavy seed crop.

***Danthonia californica*—California Oatgrass:** This native perennial occurs in dry to moist meadows and tends to occur more often in foothill areas. All *Danthonia* species tend to increase in abundance with moderate to heavy grazing, and since they are usually identified correctly, even in vegetative stages, they are good indicator species. While the species is a bunchgrass, without rhizomes, its physiognomy appears like a sod-forming grass.

***Elymus glaucus*—Blue Wildrye:** Blue wildrye is a native perennial that is softer-leaved than most *Elymus* species and is fairly good forage for cattle but not very palatable to sheep. It is not a primary forage plant. It withstands drought remarkably well but does not withstand continued heavy grazing. Blue wild rye appears to be wholly dependent on seed for reproduction. Its primary habitat is in partial shade of oak canopies where it usually does not form dense monoculture stands. It is subject to rust fungal infections and thus it does not grow vigorously under the high humidity conditions of nursery settings for seed production. The species is relatively short-lived but reproduces well from seed in shaded habitats where biomass of neighboring plants is not too high. It is a member of late seral oak woodland, oak savanna and many conifer plant communities. It colonizes sites rather effectively so it is present in mid-seral and relict stands. It is probably the most common native perennial bunchgrass in the foothills of California.

***Hordeum marinum* ssp. *gussoneanum (H. geniculatum)*—Mediterranean Barley:** This annual species was introduced from Europe and is now naturalized throughout California. It is found on periodically wet, early dry soils. Cover is higher on compacted or high clay soils with high water holding capacity. It has value to livestock only in the early season, as it flowers early in the year and its inflorescence repels grazing animals.

***Juncus* spp.—Rush:** These grasslike plants are low cover native perennials that produce poor forage value due to their tough stems and waxy leaf surfaces. They often grow in depressions or moist areas and are not favored by livestock. They do not withstand de-watering or trampling well but when abundant they hold soil fairly well. They increase in dominance on wet sites and during a series of wet years.

***Luzula comosa*—Common Woodrush and *Luzula subcongesta*—Mountain Woodrush:** These native perennials are are the most commonly recorded *Luzula*s. They occur on moist soils in meadows and also in adjacent lodgepole pine forests. *Luzula comosa* is a montane species and is found in moist/wet montane meadows and wooded riparian areas. *Luzula subcongesta* is found in subalpine to alpine meadows and along streambanks. The *Luzula*s are susceptible to grazing and trampling and indicate relatively high species diversity and later seral conditions. Other *Luzula* species are *Luzula divaricata* and *Luzula parviflora*, which are mostly forest to alpine upland species.

***Poa pratensis*—Kentucky Bluegrass:** Kentucky bluegrass is a perennial non-native species that will grow on a wide diversity of sites but grows best on well-drained loams or clay loams, which are rich in humus. On

such fertile sites it can attain such a density as to crowd out all other species. It is often found on wet sites, but unlike the redtop species, it does not thrive on acid soils or on water-logged sites. It usually produces an abundance of nutritious forage and lush herbage that all classes of livestock and wildlife grazers find palatable. It is highly tolerant of heavy utilization, being able to not only maintain itself, but also to increase even on heavily trampled areas where the plants are cropped closely. Kentucky bluegrass produces an abundance of high-quality seed and a dense sod resistant to trampling and erosion due to creeping rhizomes and deep fibrous roots. Its sod does not support streambanks to near the degree of resilience as many sedge species.

***Poa secunda*—Sandberg Bluegrass:** This native perennial bluegrass usually inhabits shallow soils and often is most common on dry, rocky, or sandy soils. It is very drought resistant and is a common survivor of overgrazing after other bunchgrass species are gone. Its deep fibrous root system enables it to withstand trampling unusually well. In many areas it performs like an annual grass. It greens up rapidly and can flower and set seed early in the season while moisture is still available. Its palatability and availability is just enough below that of other species to avoid focused grazing pressure. It grows early and is relatively palatable season-long. Given its rapid phenological development, it is usually grazed during or after seedset. Seed viability is only fair. As a bunchgrass it cannot spread laterally due to lack of rhizomes, so is dependent on seed for reproduction.

Sandberg bluegrass is relatively short-lived, but reproduces by seed very successfully. It colonizes disturbed sites and is often present in late-seral communities. It is a good indicator of grazing pressure and is the most sensitive of all *Poa*s to grazing. It is early-mid seral in sagebrush-steppe communities.

***Elymus elymoides* (*Sitanion hystrix*)—Bottlebrush Squirreltail:** Squirreltail is a native perennial that is highly variable in size, coarseness, slenderness of stems, length and shape of leaves, quantity of hairs, number of shoots, and relative lengths of awns. It grows primarily on dry, gravelly soils or in saline flats, in grassland, weedy sites and in shrublands. It is abundant in small local areas, but is usually in a scattered distribution. It is fair to good forage before heading and is generally associated with better forage plants.

Squirreltail is one of the first perennials to colonize early seral communities during secondary succession. It could be considered a mid-seral species in many situations. It is a prime candidate species for restoration.

***Stipa* (now *Nassella cernua*, *N. pulchra*, *N. lepida*, *Achnatherum lemmonii*, *A. nelsonii* ssp. *dorei*, *A. occidentalis*) —Needlegrass species:** Needlegrass species are native perennials whose foliage tends to be wiry and occasionally coarse especially when mature. The foliage usually remains green, especially at the base, for a long growing period. Root systems are deep, plants are prolific seeders, and they are tolerant of livestock grazing. Most needlegrasses are very long-lived and are late seral, although many are remnant or relict members of annual grass-dominated communities. Because of their resilience, needlegrasses are not good indicators of light grazing history.

***Taeniatherum caput-medusae*—Medusahead:** An introduced annual grass from the Mediterranean, it is now naturalized on low to mid elevation sites. It is an aggressive, noxious, late-flowering weed that produces a heavy seed crop. Its herbage contains silica which retards decomposition and results in dense litter that can persist for over two years, inhibiting germination of and excluding most other species. It grows in soils with high clay content, well developed profiles and in areas receiving runoff from infested areas. It has made its greatest gain in encroachment over the last 30 years.

***Vulpia* spp.—Annual Fescues:** Many annual fescues are such aggressive colonizing species that they are weed pests. They often inhabit compacted soils on foothills that have been overgrazed. Here they supply more or less early forage and provide a measure of soil protection in the absence of later-seral plants. 'Zorro' fescue is a cultivar of *Vulpia myuros* or foxtail fescue (formerly *Festuca megalura*) that was developed for erosion control on difficult-to-revegetate sites. It is an aggressive weed under many circumstances; its use in wildland settings should be avoided. *Vulpia microstachys* and *V. octoflora* are two native fescues that are not aggressive like their exotic relatives. Their presence on unproductive serpentine sites could be rated at all seral stages from early to late depending on their neighboring species in the community.

Annual grassland indicator forbs:
Many forbs are very good indicators of species diversity, meadow seral stage and soil water status. Almost all the common forbs discussed below are native; those that are exotic and/or introduced are noted. **This section has yet to be completed and will follow the species list included in Table AG-3.**

***Achillea millifolium*—Yarrow:** This is a very common native perennial forb that indicates drier conditions and disturbance, often by small mammals. It readily invades overgrazed sites and makes colonization difficult for later seral, less grazing-resistant, palatable species.

***Erodium cicutarium*—Storksbill:** Presence of this non-native annual indicates harsher, drier sites than the more common *E. botrys* is found in.

***Limnanthes douglasii*—Douglas' Meadowfoam:** This native, annual species is usually found in concave lower slope positions where it indicates high water holding capacity and species diversity and well developed soils.

***Rumex acetosella*—Sheep Sorrel:** This perennial exotic forb is very common in disturbed, moist areas in all kinds of habitats.

***Ranunculus occidentalis*—Western Buttercup:** This perennial native is generally found in moist to dry meadows, vernally wet meadows or lower slopes, and indicates disturbance conditions if present in large numbers.

Historic, Contemporary and Commercial Use of Annual Grassland Plants

Historic and Contemporary Uses: Many of the species in the annual grassland type have been utilized for various purposes both historically and in contemporary times (Appendix VI.) Historically, a significant food supply was provided through the harvest of various grass seeds such as wild oat (*Avena fatua*) and blue wildrye (*Elymus glaucus*) cooked as gruel, the harvest and baking of bulbs and tubers such as wild onions (*Allium* spp.), yampah (*Perideridia* spp.) and brodiaeas (*Brodiaea, Dichelostemma* and *Tritelia* spp.), the gathering of berries such as raspberry (*Rubus* spp.) and wild grape (*Vitis californica*), and greens from forbs such as plantain (*Plantago lanceolata*) and sheep sorrel (*Rumex acetosella*).

Though they were not as abundant in the annual grasslands as in other plant communities, several plants were gathered from grasslands for purposes besides nourishment. For instance, bracken fern (*Pteridium aquilinum*) roots and stems of goldenback fern (*Pentagramma triangularis*) were used in basketry. Indian hemp (*Apocynum cannabinum*) stems and wild iris (*Iris macrosiphon*) leaves provided cordage. Common dandelion (*Taraxacum officinale*) roots provided a dye as well as remedies for several ailments and its leaves were used as well in medicinal teas. Other grassland plants had multiple uses; for example, soap plant (*Chlorogalum pomeridianum*) bulbs were used for food, to stupefy fish, for soap and shampoo and as a salve for poison-oak rash (Davis 1991).

Some of these plants are still harvested today for personal use. Sustenance and medicine are the most common among a range of uses. Bulbs and berries provide food, for instance, and several forbs including yarrow (*Achillea millefolium*), coyote mint (*Monardella odoratissima*) and common dandelion are harvested for medicinal purposes.

Commercially Harvested Species: Several of the species found in the annual grasslands that have historic and current uses are monitored by Northern Province Forests as special forest products. Some of the more important commercially harvested species across the Northern Province are discussed in detail here, as this method of harvest tends to be carried out on a large and not necessarily sustainable scale, and is therefore most likely to impact on rangeland ecosystems (Heffner 2001).

In the annual grasslands, these species include the noxious weed, *Hypericum perforatum*, as well as the weedy non-native forbs, *Plantago lanceolatum*, *Rumex acetosella*, *Rumex crispus* and *Taraxacum officinale*, and the weedy native forb, *Verbena lasiostachys*. As they are weedy, these plants are considered least sensitive to harvest. More sensitive commercially harvested species include the natives *Arctostaphylos patula*, *Equisetum arvense*, *E. laevigatum* and *Prunella vulgaris* (Everett 1997).

Sheep sorrel (*Rumex acetosella)* was most ubiquitous of these species in the annual grasslands. It was found in 10 (67%) of the 15 plant associations, with mean cover of 4.6%. It was most common in the *Arrhenatherum elatius-Cynosurus echinatus/Dichelostemma capitatum, Cynosurus echinatus-Bromus hordeaceus-Avena fatua*, and *Cynosurus echinatus/Lagophylla/ Rock* associations with 2-7% cover and 58-84% constancy within these associations. Sheep sorrel is used in cancer treatment and as a salad green.

Common yarrow *(Achillea millefolium)* was found in 8 (55%) of the 15 plant communities, with mean cover of 5.8% and mean constancy of 30%. It was most common and abundant in the *Arrhenatherum elatius-Cynosurus echinatus* and *Cynosurus echinatus/Lagophylla//Rock* associations with 3 to 5% cover and 75 to 84% constancy within associations. Common yarrow is used in several medicinal remedies and produces a dye.

Common dandelion (*Taraxacum officinale*) was found in 100% of the *Cynosurus echinatus-Bromus hordeaceus-Taraxacum officinale* and *Cynosurus echinatus-Bromus hordeaceus-Avena fatua* associations with 1-15% cover within associations. It was also found in 54% of the remaining grassland plant associations at 1-2% cover, with highest constancy (63%) in the *Arrhenatherum elatius-Cynosurus echinatus/Dichelostemma capitatum* association. Common dandelion is used for various medicinal remedies and produces a dye.

St. John's wort (*Hypericum perforatum*) was found in 7 (47%) of the annual grass communities, with an average cover of 1.7%. It was most common in the *Cynosurus echinatus*-Tarweed association with 74% constancy. St. John's wort is used for various medicinal remedies and produces a dye.

Curly dock (*Rumex crispus*) was found in 6 of the 15 annual grassland communities and had its highest constancy (80%) in the *Cynosurus echinatus*/Tarweed association. Curly dock is used for various medicinal purposes and as a salad green. Western verbena (*Verbena lasiostachys*) was found in five of the annual grassland associations and had its highest constancy (25%) in the *Cynosurus echinatus-Bromus hordeaceus-Bromus tectorum* association. English plantain (*Plantago lanceolata*) was found in 4 of the 15 plant communities and had its highest constancy (70%) in the *Cynosurus echinatus-Bromus hordeaceus-Avena fatua* association. Both verbena and English plantain are used in various medicinal applications. Each of these species averaged 1% cover.

None of the non-weedy commercially harvestable species was common in the annual grasslands; each was found in only one plant association. Smooth scouring-rush (*Equisetum laevigatum*) was found in 100% of the *Bromus hordeaceus/Erodium botrys* plots at 10% cover. Common scouring rush (*Equisetum arvense*) was found in one *Arrhenatherum elatius-Cynosurus echinatus/Dichelostemma capitatum* var. *capitatum* plot at 1% cover. The scouring rushes are used in various medicinal preparations, the fiber is used for scouring, and the shoots and roots are edible. Greenleaf manzanita (*Arctostaphylos patula)* was found in one *Bromus hordeaceus-Aira caryophyllea-Dichelostemma capitatum* var. *capitatum* plot with 2% cover. Greenleaf manzanita is used in a medicinal tea. Self-heal (*Prunella vulgaris*) was found in one *Bromus hordeaceus-Limnanthes douglasii-Trifolium* plot at 1% cover. Self-heal is used in various medicinal applications. There were no special forest product species found in the *Phalaris* series.

Vegetation classification

Four existing vegetation alliances were identified from 201 plots within the annual grassland vegetation type. These were the *Arrhenatherum elatius, Phalaris aquatica, Bromus hordeaceus* and *Cynosurus echinatus* alliances. One plant association each was described in the *Arrhenatherum elatius* and *Phalaris aquatica* alliances, while six plant associations were described in each of the *Bromus hordeaceus* and *Cynosurus echinatus* alliances (Table AG-4). These groups of species best fit into the Valley Grassland (SRM 215) cover type of Bartolome and Brown (1994).

Table AG-4. Plant associations described in the annual grassland vegetation type with plant species codes.

Code	Plant Association
AREL3-CYEC/DICAC5	*Arrhenatherum elatius-Cynosurus echinatus/ Dichelostemma capitatum* ssp. *capitatum*
PHAQ-BRHO2/CESO3	*Phalaris aquatica-Bromus hordeaceus/ Centaurea solstitialis*
BRHO2/LIDO/TRIFO	*Bromus hordeaceus/Limnanthes douglasii-Trifolium* spp.
BRHO2-AICA/ERODI	*Bromus hordeaceus-Aira caryophyllea/Erodium* spp.
BRHO2-AICA/DICAC5	*Bromus hordeaceus-Aira caryophyllea/ Dichelostemma capitatum* ssp. *capitatum*
BRHO2-TACA8/ERBO	*Bromus hordeaceus-Taeniatherum caput-medusae/ Erodium botrys*
BRHO2-BRTE	*Bromus hordeaceus-Bromus tectorum*
BRHO2/ERBO	*Bromus hordeaceus/Erodium botrys*
BRHO2/DIMU5-GRCA	*Bromus hordeaceus/Dichelostemma multiflorum-Grindelia camporum*
CYEC/HECOL-MADIA	*Cynosurus echinatus/Hemizonia congesta* ssp. *luzulaefolia-Madia* spp.
CYEC-BRHO2/TAOF	*Cynosurus echinatus-Bromus hordeaceus/ Taraxacum officinale*
CYEC/LAGOP//Rocky	*Cynosurus echinatus/Lagophylla spp.//Rocky*
CYEC-BRHO2-AVFA	*Cynosurus echinatus-Bromus hordeaceus-Avena fatua*
CYEC-BRHO2-TACA8	*Cynosurus echinatus-Bromus hordeaceus-Taeniatherum caput-medusae*
CYEC-BRHO2-BRTE	*Cynosurus echinatus-Bromus hordeaceus-Bromus tectorum*

An environment comparison of the four alliances using discriminant function analysis showed them to be distinct from one another (fig AG-1, p. 21). A table of significant ($P \leq .05$) environment variables that help discriminate between the alliances is contained in Table AG-5 (p. 21). A description of each alliance and its relationship to the others and to its environment follows. A key to the annual grassland vegetation alliances follows the alliance descriptions.

Arrhenatherum elatius alliance

The *Arrhenatherum elatius* alliance was characterized by its relatively close proximity to the Pacific Ocean and its location on west and east facing, mid-elevation sites in the northern portion of the annual grassland gradient. Micro-positions were primarily ridgetops and middle 1/3 slopes, with undulating, gentle slopes and low surface bare ground, gravel and rock. Mean annual precipitation was the highest and mean annual temperature was the lowest of all annual grassland alliance (Table AG-5, Appendix IV).

Soils were derived from coarse textured, hard sedimentary rock. Soil surfaces were protected with the thickest litter layer (O horizon) and percent cover in the annual grassland type. A horizon thickness and percent clay were also the highest, while coarse fragment content was the lowest in the type. These factors combined with mostly deep soils and the near absence of an Argillic horizon contribute to a high water storage capacity (Appendix III).

Total vegetation cover and total grass cover were the highest in the annual grassland type. This is likely due to the cooler and wetter environment described above. In contrast, total forb cover was the lowest of all alliances in the annual grassland type. This probably results from the tall stature of *Arrhenatherum elatius* and its resulting surface shade, as well as the high amount of organic litter produced, suppressing forb germination (Table AG-5, Appendix IV).

One plant association, the *Arrhenatherum elatius-Cynosurus echinatus/ Dichelostemma capitatum ssp. capitatum* type was described from this alliance (Table AG-4). Therefore, the description of the alliance and the plant association are the same.

***Phalaris aquatica* alliance**

The *Phalaris aquatica* alliance was found on type converted chaparral sites. It was located on low elevation, inland sites in the southern end of the Northern California Coast Range section. Micro-position was middle 1/3 on gentle slopes with convex and linear micro-relief. Precipitation here was lowest and mean annual temperature was highest. Bare ground cover and surface rock and gravel were low (Table AG-5, Appendix IV).

Soils were derived from the coarse textured, volcanic, rhyollite rock. Soil surfaces had a thick litter layer (O horizon) of low cover. A-horizon thickness, percent clay and coarse fragment content were high (Appendix III).

Total vegetation cover and forb cover were among the highest, while grass cover was the lowest in the annual grassland type (AG-5, Appendix II).

One plant association, the *Phalaris aquatica-Bromus hordeaceus/Centaurea solstitialis* type (Table AG-4) was described from this alliance. Therefore, the description of both alliance and plant association are the same.

***Bromus hordeaceus* alliance**

The *Bromus hordeaceus* alliance was characterized by its warm south and east facing mid-elevation sites throughout southern portion of the Northern California Coast Range Section. Micro-positions were upper 1/3 through lower 1/3 slopes, with linear, moderate slopes and high surface bare ground and moderate gravel and rock. Mean annual precipitation was on the low end and mean annual temperature was among the highest of all annual

grassland alliances (Table AG-5, Appendix IV).

Soils were derived from the coarse-textured, soft, sedimentary rocks, sandstone, siltstone and argillite. Soil surfaces had thin litter layers (O horizon) of low cover. A horizon thickness and percent clay were high, while coarse fragment content was among the lowest in the type. Soil depth was deep and moderately deep with frequent argillic horizons (Appendix III).

Total vegetation cover was the lowest in the annual grassland type. Total grass cover was also low while forb cover was among the highest in the annual grassland type (Table AG-5, Appendix II).

Seven plant associations were described in the *Bromus hordeaceus* alliance (Table AG-4): *Bromus hordeaceus/Limnanthes douglasii-Trifolium* spp.*; Bromus hordeaceus-Aira caryophyllea/Erodium* spp.*; Bromus hordeaceus-Aira caryophyllea/Dichelostemma capitatum* ssp. *capitatum; Bromus hordeaceus-Taeniatherum caput-medusae/Erodium botrys; Bromus hordeaceus-Bromus tectorum, Bromus hordeaceus/Erodium botrys* and *Bromus hordeaceus/Dichelostemma multiflorum-Grindelia camporum* types.

***Cynosurus echinatus* alliance**

The *Cynosurus echinatus* alliance was found on warm, southwest, south and east facing upper elevation sites throughout the southern portion of the Northern California Coast Range Section. Micro-positions were upper and middle 1/3 slopes with variable micro-relief, high bare ground and high surface gravel and rock. Precipitation was the second highest in the annual grassland type and temperature was among the lowest (Table AG-5, Appendix IV).

Soils were derived from the coarse textured, soft sedimentary rocks, sandstone and argillite. Soil surfaces had thin litter layers (O horizon) of low cover. A horizon thickness was moderate and percent clay low, while coarse fragment content was the highest in the type. Soil depth was deep and moderately deep with frequent argillic horizons. Surface clay percent was the lowest in the type (Appendix III).

Total vegetation cover was in the low end and total grass cover among the highest in the annual grassland type (Table AG-5, Appendix II).

Six plant associations were described in the *Cynosurus echinatus* alliance (Table AG-4): *Cynosurus echinatus/Hemizonia congesta* ssp. *luzulaefolia-Madia* spp.*; Cynosurus echinatus-Bromus hordeaceus/Taraxacum officinale; Cynosurus echinatus/Lagophylla* spp.//Rocky; *Cynosurus echinatus-Bromus hordeaceus-Avena fatua; Cynosurus echinatus-Bromus hordeaceus-Taeniatherum caput-medusae* and *Cynosurus echinatus-Bromus hordeaceus-Bromus tectorum* types.

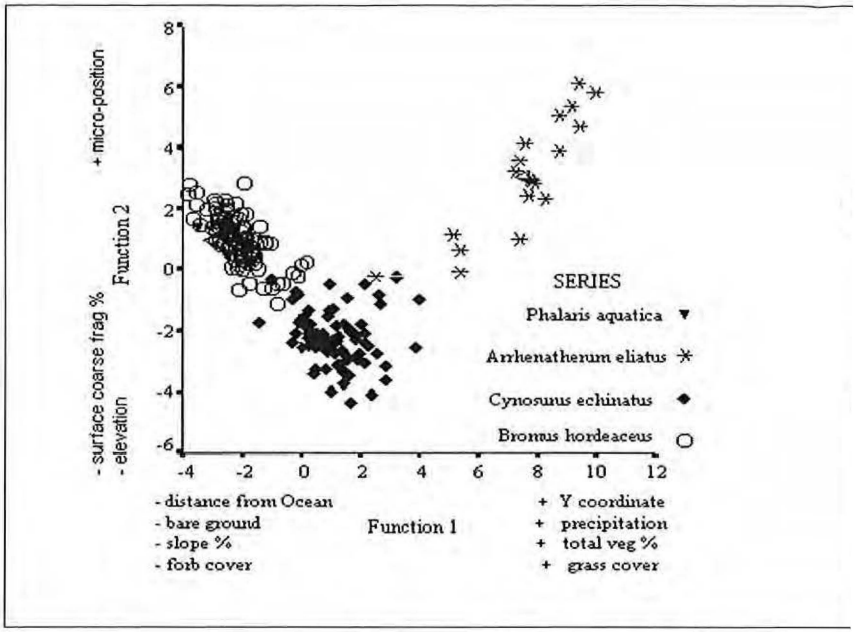


Figure AG-1. Graph of canonical discriminant functions (1 & 2) separating alliances in the annual grassland vegetation type. Significant variables (P < .05) correlated with each function are listed adjacent to each function and in Table AG-5.

Table AG-5. Comparison table of significant discriminant variables (P < .05) separating alliances in the annual grassland vegetation type.

Variables	BRHO2	CYEC	AREL3	PHAQ
Distance to Ocean (mi)	37.9	34.9	29.0	59.9
Y coordinate	4426897.5	4465709.3	4499199.1	4397933.8
Precipitation (in)	60.1	67.4	76.6	39.3
Annual temperature (°F)	52.1	50.7	50.5	52.9
% Bare ground	11.5	7.4	1.7	1.5
Depth to Argillic horizon (in)	20.0	21.5	42.8	10.0
Slope %	30	23	19	22
% Total forb cover	41	32	29	24
% Total grass cover	55	61	80	67
Surface pH	6.5	6.2	6.1	7.0
% Surface clay	22	17	24	20
A horizon thickness (in)	9	14	15	10
Radiation index	.532	.495	.499	.426
% Surface gravel & rock	8	12	2	3
Elevation (ft)	2893	3331	3143	2314

Annual Grassland Vegetation Alliance Key

1a. *Arrhenatherum elatius* is the dominant species.....
.....*Arrhenatherum elatius* Alliance

1b. *Arrhenatherum elatius* absent or not dominant..... 2

2a. *Phalaris aquatica* is the dominant grass species.....
.....*Phalaris aquatica* Alliance

2b. *Phalaris aquatica* absent or not dominant..... 3

3a. *Bromus hordeaceus* is the dominant grass species, can be codominant with *Cynosurus echinatus*.....
.....*Bromus hordeaceus* Alliance

3b. *Bromus hordeaceus* absent or not dominant..... 4

4a. *Cynosurus echinatus* is the dominant grass species (can be codominant with *Bromus hordeaceus*) .....
.....*Cynosurus echinatus* Alliance

4b. *Cynosurus echinatus* absent or not dominant.....
check major vegetation category, note dominant species and submit with location map to Province Ecologist.

***Bromus hordeaceus* Alliance**

Ecological classification within the *Bromus hordeaceus* alliance identified six plant associations (Table AG-4). They differed significantly from one another by environment (fig. AG-2). A list of significant vegetation and environment variables separating these associations is contained in Table AG-6.

Figure AG-2 indicates that the *Bromus hordeaceus/Erodium botrys* community was substantially different from all other associations in the alliance. This is due to the inland position of the type where precipitation was low, and elevation, total vegetation, and grass cover were high. A horizons and the litter layer were thick, clay percent was moderate and depth to argillic horizon was the highest in the alliance (Table AG-6).

The *Bromus hordeaceus-Taeniatherum caput-medusae/Erodium botrys* community was also significantly different from the rest of the alliance (fig. AG-2). It was found on mid-elevation, inland sites with low annual precipitation. Grass cover was high, forb cover low, A horizons were thick and depth to argillic was high (Table AG-6).

The *Bromus hordeaceus-Bromus tectorum* community was also different from the rest of the associations in the alliance (fig. AG-2). It was found on upper 1/3, high elevation, inland sites with the highest mean annual precipitation, bare ground and surface gravel and rock cover in the alliance. Clay percent was the highest and depth to the argillic horizon was the lowest in the alliance. The result of these factors was the lowest mean total vegetation and forb cover in the alliance (Table AG-6).

Figure AG-2 also shows us that the *Bromus hordeaceus/Limnanthes douglasii-Trifolium* spp., *Bromus hordeaceus-Aira caryophyllea/Erodium* spp. and *Bromus hordeaceus-Aira caryophyllea/Dichelostemma capitatum* ssp. *capitatum* associations were more similar to one another than to the three previously described associations. A close examination of the X axis shows us that the gradients separating the first three types were much wider than the last three. Because of this a second discriminant analysis was run separately on the last three types.

The second discriminant run in the *Bromus hordeaceus* alliance shows clear distinctions between the *Bromus hordeaceus/Limnanthes douglasii-Trifolium* spp., *Bromus hordeaceus-Aira caryophyllea/Erodium* spp. and *Bromus hordeaceus-Aira caryophyllea/Dichelostemma capitatum* associations. The *Bromus hordeaceus/Limnanthes douglasii-Trifolium* spp. community was found on lower elevation, moist lower 1/3 slope positions with gentle slopes and high mean annual precipitation. A horizons were the thickest in the alliance, clay content and depth to argillic were high.

Total vegetation cover and forb cover were the highest in the alliance while grass cover was also high (Table AG-6).

The *Bromus hordeaceus-Aira caryophyllea/Erodium* spp. plant association was found on mid elevation sites with moderate slopes in upper 1/3 slope positions in close proximity to the Pacific Ocean. Bare ground, along with surface gravel and rock cover, was among the highest in the alliance. Grass and forb cover were also among the highest in the alliance (Table AG-6).

The *Bromus hordeaceus-Aira caryophyllea/Dichelostemma capitatum* ssp. *capitatum* association was found on low elevation, moderately steep, middle 1/3 slope, warm sites with high mean annual precipitation. Bare ground was high, while surface gravel and rock cover were moderate. A horizon thickness was low, as was depth to the argillic horizon. These factors are likely related to the moderate total vegetation cover and the lowest grass cover in the alliance (Table AG-6).

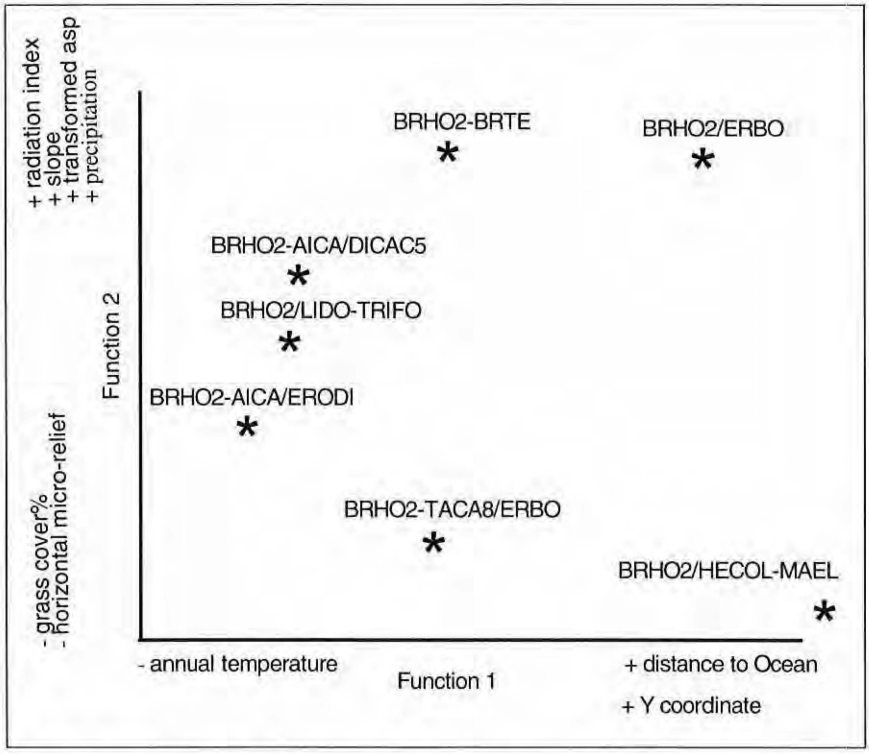


Figure AG-2. Graph of canonical discriminant functions separating plant associations in the *Bromus hordeaceus* alliance. Significant variables ($P < .05$) correlated with each function are displayed adjacent to each function and listed in Table AG-6.

Table AG-6. Comparison table of significant variables (P < .05) separating plant associations in the Bromus hordeaceus alliance.

VARIABLES:	BRHO2 /LIDO -TRIFO	BRHO2- -AICA /ERODI	BRHO2/ -AICA/ /DICAC5	BRHO2- -TACA8/ /ERBO	BRHO2- -BRTE	BRHO2/ /ERBO	BRHO2/ DIMU5- GRCA
Distance to Ocean (mi)	34.2	30.4	33.3	43.6	41.4	56.5	55.0
Precip. (in)	63.9	60.6	65.0	50.0	63.9	48.0	41.0
Y coord.	4437109.5	4437377.5	4441286.3	4375759.8	4467923.5	4395214.8	4414994.7
Elevation (ft)	2742	3153	2695	3101	3684	3601	3995
Radiation index	.506	.524	.551	.506	.533	.551	.503
% Bare ground	7	12	12	9	25	8	13
% Grass cover	60	62	45	63	55	64	83
Total veg %	91	79	77	77	70	85	86
Slope %	22	30	36	26	30	29	23
% Surface gravel & rock	2	11	9	8	16	5	4
Micro-position	lower 1/3	upper 1/3	middle 1/3	middle 1/3	upper 1/3	middle 1/3	middle 1/3
% Forb cover	53	42	43	31	26	47	13
Litter thickness (in.)	0.2	0.0	0.1	0.8	0.2	1.0	0.5
A horizon thickness (in)	13	7	6	9	6	13	10
Depth to Argillic horizon (in)	19	12	13	34	6	31	29
Clay % maximum	39	31	34	35	48	29	25
Surface pH	6.6	6.5	6.2	6.7	6.8	6.8	6.7

Cynosurus echinatus alliance

Ecological classification within the *Cynosurus echinatus* alliance identified six plant associations (Table AG-4). They differed significantly from one another by environment (fig. AG-3). A list of significant vegetation and environment variables (P $\leq$.05) separating these associations is contained in Table AG-7.

The *Cynosurus echinatus-Bromus hordeaceus-Bromus tectorum*, *Cynosurus echinatus/Lagophylla* spp.//Rocky and *Cynosurus echinatus-Bromus hordeaceus-Avena fatua* associations appear most different from all other members of the alliance (fig. AG-3). The *Cynosurus echinatus-Bromus hordeaceus-Avena fatua* community was found in close proximity to the Pacific Ocean, on low elevation sites, on gentle middle 1/3 slopes, with the highest mean precipitation in the alliance. Depth to the argillic horizon and litter cover were the highest in the alliance. Total vegetation cover and grass cover were high, while forb cover was moderate (Table AG-7).

The *Cynosurus echinatus-Bromus hordeaceus-Bromus tectorum* plant association was found on high elevation sites, with moderate slopes in upper 1/3 slope positions. Precipitation was high while mean annual temperature was low. Bare ground was the highest in the alliance, while surface gravel and rock were also high. Total vegetation cover, grass cover and forb cover were all low (Table AG-7).

The *Cynosurus echinatus/Lagophylla* spp.//Rocky plant association was found on high elevation sites, with moderately steep slopes in middle 1/3 slope positions. Mean annual precipitation was high, while mean annual temperature was the lowest in the alliance. Soil depth was the lowest in the alliance, while depth to the argillic and clay content was also low. Surface gravel and rock cover were the highest in the alliance, as was grass cover, while forb cover was low (Table AG-7).

Figure AG-3 also shows us that the *Cynosurus echinatus/Hemizonia congesta* ssp. *luzulaefolia-Madia* spp., *Cynosurus echinatus-Bromus hordeaceus-Taeniatherum caput-medusae* and *Cynosurus echinatus-Bromus hordeaceus/Taraxacum officinale* associations were more similar to one another than the three previously described associations. A close examination of the X axis shows that the gradients separating the first three types were much wider than the last three. Because of this a second discriminant analysis was run on the last three types alone. The results of this analysis are described below.

The second discriminant analysis run clearly shows good separation between the three remaining associations. The differences between the associations are described here. The *Cynosurus echinatus/Hemizonia congesta* ssp. *luzulaefolia-Madia elegans* plant association was found on mid elevation sites, with gentle slopes in upper 1/3 slope positions. Precipitation here was high as was mean annual temperature. Soils were deep, clay content was high and depth to argillic horizon was variable. This resulted in the lowest grass cover in the alliance and the highest forb cover. This is likely due to the restrictive nature of grass root penetration

by argillic horizons and the ability of the tarweed forb species to penetrate these layers (Table AG-7).

The *Cynosurus echinatus-Bromus hordeaceus/Taraxacum officinale* plant association was found on mid elevation, moderately steep, upper 1/3 slopes with low precipitation and high mean annual temperature. Soils were deep with high clay percent and moderately deep argillic horizons. Total vegetation, grass and forb cover were among the highest in the alliance.

The *Cynosurus echinatus-Bromus hordeaceus-Taeniatherum caput-medusae* plant association was found on mid elevation sites, with gentle slopes in upper 1/3 slope positions. Precipitation was high while mean annual temperature was low. Bare ground was also high while surface gravel and rock were moderate. Soils were deep, clay content was high and depth to argillic was moderate. Total vegetation cover was low, grass cover was moderate and forb cover was the lowest in the alliance (Table AG-7).

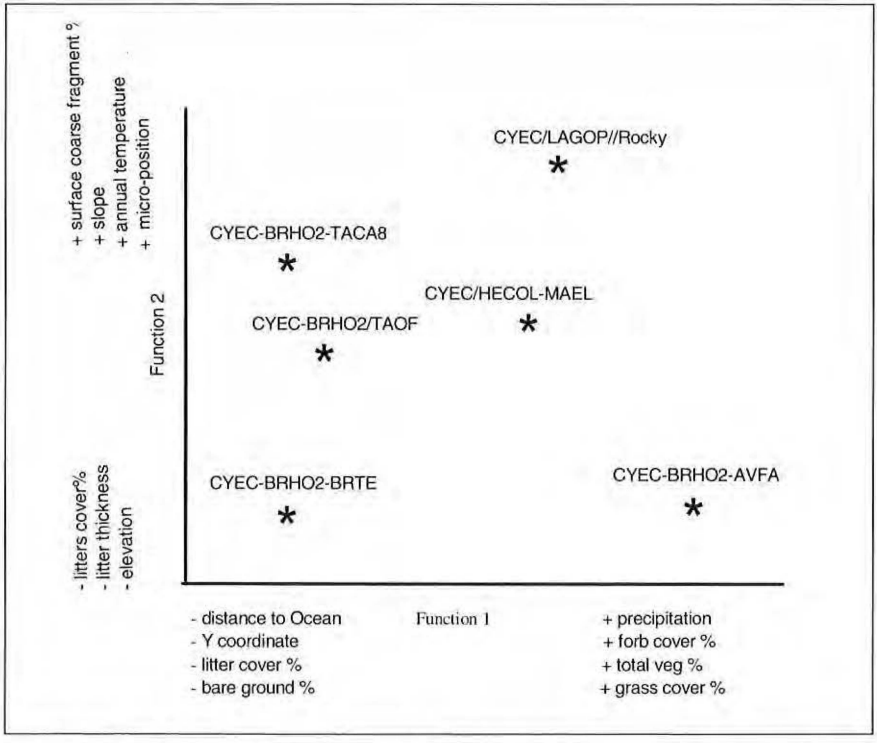


Figure AG-3. Graph of canonical discriminant functions separating plant associations in the *Cynosurus echinatus* alliance. Significant variables ($P < .05$) correlated with each function are displayed adjacent to each function and listed in Table AG-7.

Table AG-7. Comparison table of significant variables ($P \leq .05$) separating plant associations in the *Cynosurus echinatus* alliance.

Variables	CYEC/ HECOL-MADIA	CYEC-BRHO2/ TAOF	CYEC/ LAGOP// ROCKY	CYEC-BRHO2-AVFA	CYEC-BRHO2-TACA8	CYEC-BRHO2-BRTE
Y coordinate	4446107.9	4437563.2	4496109.3	4500011.1	4456642.4	4462294.8
Distance to Ocean (mi)	37.1	29.7	34.1	27.9	36.6	39.6
Precipitation (in)	65.0	55.0	75.8	76.0	65.4	63.7
% surface gravel & rock	9	3	37	3	6	11
Annual temp. (°F)	51.5	52.1	49.6	50.5	50.8	49.8
% Forb cover	51	41	30	35	19	23
% Grass cover	43	74	76	70	61	54
% Bare ground	3	8	4	3	11	15
Elevation (ft)	3282	3220	3813	2876	3185	3784
Slope %	23	29	30	22	19	23
Micro-position	upper 1/3	upper 1/3	middle 1/3	middle 1/3	upper 1/3	upper 1/3
% Litter cover	1	0.0	29	91	9	6
% A horizon clay	21	21	9	21	22	35
Clay % maximum	35	35	18	28	40	48
Total soil depth (in)	50	50	25	42	50	33
Litter thickness (in)	0.4	0	0.1	0.4	0.3	0.2
Depth to Argillic horizon (in)	23	22	13	30	16	6

Species Diversity:

Species diversity in annual grassland systems is a controversial subject. It is thought by many that the California annual grasslands were once dominated by perennial grasses. After the introduction of aggressive non-native, annual, Mediterranean species many of the native species were displaced. Current theories suggest that there was more of a balance of native annual and perennial species. One thing is very clear from this study; the annual grasslands of the Northern Province are now dominated

by non-native annual grasses and a combination of native and non-native forbs. The question now is, can these altered systems be managed to increase native species composition? An attempt will be made to answer this by examining species composition at the alliance and plant association scales and proposing management actions that might be implemented.

Three diversity measures were used here to examine the annual grasslands of the Northern Province: species richness, evenness and Shannon diversity index. Species richness is the number of species identified on each plot. Evenness examines how the data are distributed among the species. Shannon diversity index combines both species richness and evenness into a single value.

The annual grassland samples indicate a relatively species-rich plant environment. A total of 331 species were identified from 201 ecology reconnaissance plots. This included 4 trees, 7 shrubs, 246 forbs and 74 grass and grass-like species (Appendix I).

Forty-one percent of the grass species identified were annuals and 59% were perennials. Only ten percent of the annual grasses were native species, while 90% were non-native. In the perennial grass category, 84% were native species, while only 16% were non-native. These figures point towards an unequal distribution of cover among a limited number of annual non-native species.

Fifty-four percent of the forbs identified were annuals and 46% were perennials. Seventy percent of the annual forbs were native and 30% were non-native. In the perennial forb category, 87% were native species, while only 13% were non-native.

Mean species richness in the annual grasslands was 20.8 species/plot and Shannon diversity index was 2.2 (Table AG-8), in a range (10-90 percentiles) from 13 to 27 species/plot and 1.6 to 2.3 Shannon diversity index. The mean number of species/plot compares favorably with meadow vegetation types (no significant difference) and falls below the diversity displayed by oak woodlands. It is recommended that we manage annual grasslands for a species rishness ranging from 16-26 species per plot and Shannon Index ranging from 1.8 to 2.6.

The *Bromus hordeaceus* alliance had the highest mean value of 21.5 species/plot and the highest Shannon index of 2.3. Second highest in species/plot at 20.1 was the *Cynosurus echinatus* alliance. It also had the second highest Shannon index value (2.1). An alliance comparison found no significant difference in species richness between alliances (P=.337). It did however identify significant differences in evenness (P=.001) and Shannon index (P=.002). This is likely due to the uneven distribution of cover in the *Arrhenatherum elatius* alliance, in which *Arrhenatherum elatius* dominates the grass layer. This likely affects the cover of the associated species by reducing seedling regeneration sites, smothering living plants

and reducing seed stalk formation (Heady 1956). Hence, the *Arrhenatherum elatius* alliance has the lowest mean value for evenness. Since evenness is part of the formula, it is not surprising that the *Arrhenatherum elatius* alliance also has the lowest mean value for Shannon diversity index.

A follow-up examination of species richness by plant association was conducted next. It found no significant difference in species richness (P=.272) in the *Bromus hordeaceus* alliance. It varied from 20.2 species/plot to 24.2 species/plot. Shannon index also showed no significant difference between plant associations (P=.487). The *Cynosurus echinatus* alliance, on the other hand, showed significant differences in both species richness (P=.005) and evenness (P=.05). It varied from a low of 16.7 species/plot in the *Cynosurus echinatus/Hemizonia congesta* ssp. *luzulaefolia-Madia* spp. type to a high of 23.8 species/plot in the *Cynosurus echinatus-Bromus hordeaceus-Bromus tectorum* type (Appendix 2).

Table AG-8. Annual grassland alliance comparison of species richness, evenness and Shannon diversity index.

Alliance		Species Richness	Evenness	Shannon Index
Bromus	mean	21.5	0.74	2.3
hordeaceus	standard error	0.6	0.009	0.04
Cynosurus	mean	20.1	0.70	2.1
echinatus	standard error	0.6	0.01	0.04
Arrhenatherum	mean	20.1	0.65	1.9
elatius	standard error	0.9	0.02	0.05
Phalaris	mean	17.6	0.67	1.9
aquatica	standard error	0.5	0.006	0.04
Annual	mean	20.8	0.72	2.2
Grassland	standard error	0.4	0.10	0.03

A variation on the previous analysis looked at mean species counts for each annual grassland alliance by life form (Table AG-9). Here it was determined that significant differences existed in native forb species richness by alliance (P=.001). They varied from a low of 8.9 species/plot in the *Cynosurus echinatus* alliance to a high of 11.3 species/plot in the *Bromus hordeaceus* alliance. Native grass species richness by alliance was also determined to be significantly different (P=.007). Here the lowest density of native grasses (0.9 species/plot) was found in the *Bromus hordeaceus* alliance and the highest density was found in the *Cynosurus echinatus* alliance (1.6 species/plot) (Table AG-9). This is likely due to the larger stature and more aggressive nature of *Bromus hordeaceus*. Because

of its larger size and higher density it has the ability to shade out associated species and thereby affect the number of native grass species found on these sites. *Cynosurus echinatus,* being mostly seed head with few leaves, does not appear to have much effect on its neighboring species.

Table AG-9. Annual grassland alliance comparison of species life form counts.

Life Form	Annual grassland alliance	Mean species count	Std. error
Forb native	*Bromus hordeaceus*	11.3	0.41
	Cynosurus echinatus	8.9	0.42
	Arrhenatherum elatius	9.2	0.77
	Phalaris aquatica	5.9	1.59
	Total	10.1	0.29
Forb non-native	*Bromus hordeaceus*	3.2	0.17
	Cynosurus echinatus	3.5	0.24
	Arrhenatherum elatius	4.2	0.36
	Phalaris aquatica	4.1	0.83
	Total	3.4	0.1
Grass native	*Bromus hordeaceus*	0.9	0.12
	Cynosurus echinatus	1.6	0.16
	Arrhenatherum elatius	1.4	0.19
	Phalaris aquatica	1.3	0.18
	Total	1.2	0.09
Grass non-native	*Bromus hordeaceus*	5.6	0.15
	Cynosurus echinatus	5.7	0.19
	Arrhenatherum elatius	5.1	0.24
	Phalaris aquatica	4.4	0.48
	Total	5.5	0.11

Ecological Status:

This section will first describe the existing condition of annual grasslands in the Northern Province from several perspectives. These include comparisons of cover and species counts of grasses and forbs, annuals and perennials and native and non-native species. The long-term successional status of these systems will be described using assigned seral species status and a short-term successional status assessment method proposed. Next, treatment methods will be proposed that aim toward recovery of these systems toward ecological balance.

Vegetation cover in the annual grasslands was usually high, with grasses accounting for 66% mean cover and forbs contributing an additional 36% mean cover. Most of the grass cover was made up of annual non-native species (57%) and perennial non-native species (5%). Native grass cover consisted of < 1% annuals and 6% perennials. This supports previous research (Heady 1958, Heady et al. 1977, Bartolome 1987) in other areas, which found that these "Mediterranean" species have displaced many of the native species, and shows the effects of long-term competition from aggressive non-native species introduced to these sites through livestock

grazing. Many of the non-native species were brought to California by the Spanish to improve rangelands. While livestock grazing certainly had a role in spreading non-native species, these species continue to spread by human traffic whether or not livestock are present.

The relative rareity of native grass species is most obvious when the frequency of native grass species/plot is examined (fig. AG-4). An examination of all annual grassland plots identified 39% of the plots with no native grasses, 25% with one native grass, 22% with two native grass species and the remaining 14% with between 3 and 5 native grass species. This clearly demonstrates the displacement of native species mentioned earlier. When native grass species counts are examined by vegetation alliance (fig. AG-4), significant differences (P=.001) are found in species count categories. For instance, the *Bromus hordeaceus* alliance had the highest frequency of plots with no native grasses (53%), compared to 27% in the *Cynosurus echinatus* alliance and 10% in the *Arrhenatherum elatius* alliance. The comparison of plots with one native grass species showed the highest frequency of plots in the *Arrhenatherum elatius* alliance (53%), compared to 23% in the *Cynosurus echinatus* alliance and 20% in the *Bromus hordeaceus* alliance. The comparison of plots with two native grass species showed the *Cynosurus echinatus* alliance (31%) to have the highest frequency of plots, with the *Arrhenatherum elatius* alliance (26%) second in plot frequency and the *Bromus hordeaceus* alliance with 16%.

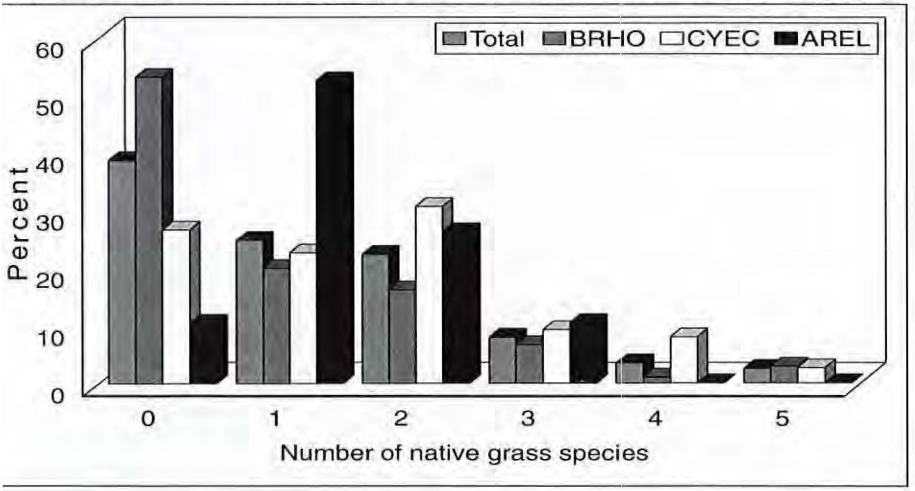


Figure AG-4. Percent of plots in native grass species count categories by annual grassland alliance.

The forb layer reverses the non-native trend with annual native and perennial native species accounting for 22% and 9% mean cover respectively. The annual native forb category differed significantly by vegetation alliance (P=.001). The *Bromus hordeaceus* alliance had the highest mean native forb cover (28%), compared to 18% in the *Cynosurus echinatus* alliance and 12% in the *Arrhenatherum elatius* alliance.

Non-native forb species were much reduced. They contributed 8% annual forb cover and 4% perennial forb cover. Both of these categories differed significantly (P=.001) between vegetation alliances. The *Bromus hordeaceus* alliance had the highest mean non-native annual forb cover (11%), compared to 4% in the *Cynosurus echinatus* alliance and 2% in the *Arrhenatherum elatius* alliance. In contrast, the *Arrhenatherum elatius* alliance had the highest mean non-native perennial forb cover (6%), compared to 5% in the *Cynosurus echinatus* alliance and 2% in the *Bromus hordeaceus* alliance.

A comparison of mean number of native forb species by vegetation alliance (fig. AG-5) showed significant differences between alliances (P=.001). The *Bromus hordeaceus* alliance had the highest mean number of native forb species (11.3 species/plot), compared to a low of 8.9 native forb species/ plot in the *Cynosurus echinatus* alliance and 9.2 native forb species/plot in the *Arrhenatherum elatius* alliance. It is likely that these competitive effects are caused by the principal species in each alliance— *Bromus hordeaceus*, *Cynosurus echinatus* and *Arrhenatherum elatius.*

An examination of native forb species counts by vegetation alliance shows a very different result than for the grasses. Native forb species counts are much higher (fig. AG-5). For example 89% of the plots had between 5 and 16 native forb species/plot. They also show significant differences (P=.001) between alliances by native forb count categories. This is particularly true in the 5-8 and 13-16 native forb species/plot categories (fig. AG-5).

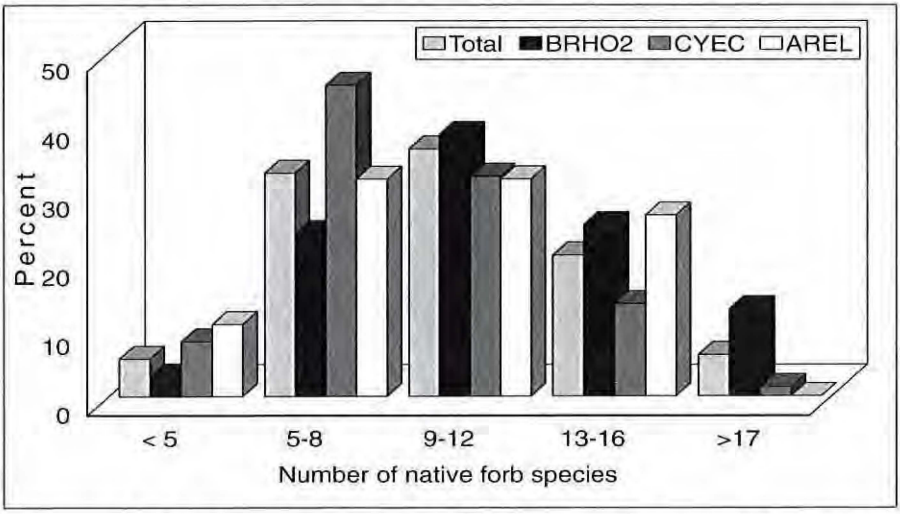


Figure AG-5. Percent of plots in native forb species count categories by annual grassland alliance.

Seral Status: The seral status of Northern California annual grasslands is a long-term record of disturbance, i.e. grazing, fire, variable precipitation and competition from invasive species. It indicates that a non-equilibrium

condition exists. The annual grassland plot samples were dominated by grass cover in the early seral stage (61%), with low grass cover in the mid seral stage (3%) and late seral stage (2%). Forb cover is similarly unbalanced with dominance in the early seral stage (30%) and low cover in both the mid seral stage (9%) and late seral stage (4%). In reference areas where disturbance was primarily natural and cattle grazing was absent the seral status was often dominated by cover in the late seral category. When the current seral status is compared to these reference areas it points toward an overall conclusion that the Northern California annual grasslands are now in a non-equilibrium condition, very disturbed or young associations dominated by invasive species. This conclusion is supported by a seral cover frequency analysis that identified 79% of the plots with $\geq$ 40% early seral species cover. Ninety-seven percent of the plots had $\geq$ 20% cover of early seral species. In contrast, 92% of the plots had $\leq$ 5% late seral species cover and 58% of these plots had no late seral cover.

When the seral status is analyzed by vegetation alliance significant differences were found between alliances for early seral cover (P=.001) and mid-seral cover (P=.005). The *Arrhenatherum elatius* alliance had the highest early-seral cover (90%). The *Bromus hordeaceus* alliance (58%) and *Cynosurus echinatus* alliance (59%) had very similar mean cover (Table AG-10). Mid-seral cover was highest in the *Cynosurus echinatus* alliance (5%), followed by the *Arrhenatherum elatius* alliance (3%) and *Bromus hordeaceus* alliance (2%) although these small differences do not appear to be ecologically significant.

Table AG-10. Mean cover and standard error for seral state by plant association.

	Early-Seral %		Mid-Seral %		Late-Seral %	
Plant Association	**Mean**	**Std. Error**	**Mean**	**Std. Error**	**Mean**	**Std. Error**
AREL3-CYEC/DICAC5	90.3	4.1	2.6	0.9	1.2	0.3
PHAQ-BRHO2/CESO3	72.1	6.1	0.0	0.0	0.3	0.3
BRHO2/LIDO/TRIFO	59.0	6.8	5.6	3.1	5.8	2.8
BRHO2-AICA/ERODI	74.0	6.3	0.4	0.2	1.3	1.1
BRHO2-AICA/DICAC5	51.3	2.7	0.2	0.1	0.3	0.1
BRHO2-TACA8/ERBO	64.2	9.4	2.3	1.5	7.9	5.4
BRHO2/BRTE	50.0	5.5	0.1	0.1	1.9	1.2
BRHO2/ERBO	61.2	10.2	1.0	0.5	2.2	1.6
BRHO2/DIMU5-GRCA	49.0	10.5	10.8	9.8	27.8	9.1
CYEC/HECOL-MAEL	36.1	5.2	6.1	2.0	2.6	1.7
CYEC-BRHO2/TAOF	80.5	5.2	6.3	2.4	0.3	0.2
CYEC/LAGOP//Rocky	74.7	5.8	3.0	1.2	3.3	1.6
CYEC-BRHO2-AVFA	71.0	6.9	4.4	3.5	0.7	0.5
CYEC-BRHO2-TACA8	56.1	6.4	6.1	1.5	2.0	1.0
CYEC-BRHO2-BRTE	53.4	6.0	0.3	0.2	0.6	0.3

The low late seral cover displayed by plant association in Table AG-10 points toward a high management emphasis rating (MER) for all annual grassland associations. The highest mean late seral cover (20.2%) was found in the *Bromus hordeaceus/Dichelostemma multiflorum-Grindelia camporum* type. It was found on the highest elevation annual grassland sites where moderate to high cover of native bunch grasses was found. The second highest mean cover of late seral species was 5.2% and it went down thereafter. In order to increase late seral cover and improve ecological status, management emphasis needs to first be directed towards the reduction in non-native species cover.

Disturbance status: The short-term (1-5 year) disturbance status of the Northern Province annual grasslands is calculated using a reduced set of non-native grasses and forbs (Table1) that indicate variable responses to disturbance (low, medium and high disturbance). Total percent cover is summed for each disturbance category. It is used to examine the current status for recent changes in cover by comparing it with the long-term seral status.

Short-term disturbance status also points toward a non-equilibrium condition. The annual grasslands had their highest grass cover in the low disturbance state (27%), with low grass cover in the medium disturbance state (1%), and intermediate cover in the high disturbance state (13%). When the short-term low disturbance cover (27%) is compared to the late seral status (2%) it is apparent that disturbance has been reduced in the short-term. This points toward an overall conclusion that Northern California annual grasslands ecological status could be improved in the short-term and likely improvements could be made in the long-term with management emphasis. An important point here is that grazing effects have not been so severe over the last 5 years that high disturbance species dominate. This is important since many sites in California have a higher early seral status vegetation composition.

When the disturbance status is analyzed by vegetation alliance, significant differences were found between alliances for early-seral cover (P=.001), mid-seral cover (P=.001) and late-seral cover (P=.002). The *Bromus hordeaceus* alliance had the greatest high disturbance cover (17%) with the *Cynosurus echinatus* alliance having low cover (9%) and the *Arrhenatherum elatius* alliance (4%) having the lowest cover (Table AG-11). All annual grassland alliances had very low medium disturbance cover. The highest was in the *Bromus hordeaceus* alliance (2%), with the *Cynosurus echinatus* alliance (< 1%) and the *Arrhenatherum elatius* alliance (0%) having the least cover. Low disturbance cover was highest in the *Bromus hordeaceus* alliance (31%), followed by the *Arrhenatherum elatius* alliance (24%) and *Cynosurus echinatus* alliance (22%).

Management Emphasis Rating (MER): Management emphasis rating (MER) is used to prioritize Northern Province rangelands for management treatment. The system is based on the cover of bare ground, litter, surface gravel and rock, noxious and invasive exotic weeds and the cover of disturbance related species that are competitive with more desirable plants. The rating system for annual grasslands includes three categories high, moderate and low based on these factors (Table AG-11).

Table AG-11. Management emphasis rating of key annual grassland environment and vegetation variables.

Environment Variables	Rating Low	Moderate	High
Bare Ground%	< 10%	10-20%	> 20%
Gravel + Rock%	< 10%	10-20%	> 20%
Litter %	> 40%	20-40%	< 20%
Noxious Weed%	< 5%	5-10%	> 10%

Using the variables in Table AG-11, a high management emphasis rating would be applied to a site with high surface gravel and rock cover (> 20%) and bare ground (> 20%), low litter cover (< 20%), presence of noxious and invasive weeds at levels conducive to management, and dominance of species related to high levels of disturbance. Not all of these factors need to be present on a site to receive a high MER. This rating is subjective, professional judgment is key in evaluating site conditions. In contrast a low management emphasis rating would be applied to a site with low bare ground (< 10%), low surface gravel and rock (< 10%), litter cover (> 40%), absence of noxious and invasive weeds, and dominance of species in the low disturbance category. A moderate emphasis rating would be intermediate between the two examples.

A site specific plot comparison identified the highest frequency of plots (55%) in the high management emphasis category. This was followed by the low management emphasis category (31%) and moderate management emphasis (14%). Fourteen percent of the high management emphasis plots resulted from high bare ground (> 20%), 10% resulted from high surface gravel and rock (> 20%), 38% resulted from low litter cover (< 10%) and 35% of the plots from high noxious and invasive weed cover (> 10%).

For a general comparison, management emphasis ratings are applied to each plant association in Table AG-12. For site specific management it is suggested that management emphasis rating be assigned to each

rangeland plot and the assigned rating be plotted on range allotment maps. This will allow for the development of an overall management emphasis rating for each range allotment or portion of an allotment based on plant association-based management strategies. Those allotments identified with a high MER would have their allotment management plans modified. It is suggested that these modifications be based on treatments discussed in the rangeland field guide.

Table AG-12. Management emphasis rating (MER) based on bare ground (%), gravel and rock cover (%), litter cover (%), noxious and invasive exotic weed (%), and disturbance status cover (%) for annual grassland plant associations.

Plant Association	Bare%	Gravel+ Rock%	Litter%	Weeds%	Disturbance% High	Med	Low	MER
AREL3-CYEC/DICAC5	2	2	86	1	4	0	24	L
PHAQ-BRHO2/CESO3	1	3	40	33	0	0	19	H
BRHO2/LIDO/TRIFO	7	2	5	1	21	0	40	L
BRHO2-AICA/ERODI	12	11	0	15	37	2	34	H/M
BRHO2-AICA/DICAC5	12	9	10	11	17	3	27	H-L
BRHO2-TACA8/ERBO	9	9	27	31	11	1	28	H
BRHO2/BRTE	25	16	10	15	18	0	22	H
BRHO2/ERBO	8	6	8	13	8	5	48	L/H
BRHO2/DIMU5-GRCA	3	4	56	6	9	7	30	L/H
CYEC/HECOL-MAEL	3	9	1	6	1	1	16	L-H
CYEC-BRHO2/TAOF	8	3	0	6	2	0	36	M
CYEC/LAGOP//Rocky	4	37	29	5	11	0	17	H
CYEC-BRHO2-AVFA	3	3	92	1	6	0	39	L
CYEC-BRHO2-TACA8	11	7	9	10	13	1	19	H
CYEC-BRHO2-BRTE	15	11	6	9	14	1	16	H

The high management emphasis rating category included seven plant associations. They are listed next with the primary environment variable responsible for the rating following in parenthesis. The high rating includes the *Phalaris aquatica-Bromus hordeaceus/Centaurea solstitialis* (noxious and invasive weeds), *Bromus hordeaceus-Taeniatherum caput-medusae/ Erodium botrys* (bare ground% and noxious and invasive weeds), *Bromus hordeaceus-Bromus tectorum* (bare ground%, surface gravel and rock and noxious and invasive weeds), *Cynosurus echinatus/Lagophylla spp.// Rocky* bare ground%, (surface gravel and rock), *Cynosurus echinatus-Bromus hordeaceus-Taeniatherum caput-medusae* (bare ground% and noxious and invasive weeds) *Bromus hordeaceus-Aira caryophyllea/*

Erodium spp., (bare ground% and noxious and invasive weeds), *Bromus hordeaceus-Aira caryophyllea/ Dichelostemma capitata ssp. capitata* (bare ground%, surface gravel and rock and noxious and invasive weeds) and *Cynosurus echinatus-Bromus hordeaceus-Bromus tectorum* (bare ground%, surface gravel and rock and noxious and invasive weeds) plant associations.

The low management emphasis rating category included three plant associations. They were the *Bromus hordeaceus/Limnanthes douglasii-Trifolium* spp., *Cynosurus echinatus-Bromus hordeaceus-Avena fatua* and *Arrhenatherum elatius-Cynosurus echinatus/Dichelostemma capitatum* ssp. *capitatum* plant associations. The latter plant association is listed in the low emphasis category, but, due to its high cover of non-native perennial grass that results in low species diversity it should be included in the high emphasis category.

The moderate management emphasis rating category included only one plant association, the *Cynosurus echinatus-Bromus hordeaceus/Taraxacum officinale* type.

Variable emphasis ratings were determined for the remaining plant associations based on bare ground%, surface gravel and rock and noxious and invasive weed cover. These plant associations included the *Bromus hordeaceus/Dichelostemma multiflorum-Grindelia camporum, Cynosurus echinatus/Hemizonia congesta* ssp. *luzulaefolia-Madia* spp., *Bromus hordeaceus/Erodium botrys* and *Cynosurus echinatus/Hemizonia congesta* ssp. *luzulaefolia-Madia* spp. plant associations.

In order to use the management emphasis rating at the landscape level, each annual grassland sample plot should be assigned an MER rating and these ratings should be plotted by range allotment. This will allow management to prioritize allotments or portions of allotments for treatment and to develop a specific strategy for each allotment based on plant association dominance.

Noxious and Invasive Weeds

Among the non-native forbs and annual grasses, four noxious and invasive weeds (*Bromus tectorum, Taeniatherum caput-medusae, Centaurea solstitialis,* and *Hypericum perforatum*) were frequently encountered throughout the range of annual grasslands (Association Tables, Appendix II).

Noxious and invasive weed cover (weed cover) was also used as a factor in determining management emphasis rating. Sixty-five percent of the annual grassland plots contained < 10% weed cover, with 20% of the plots containing 10-20% weed cover and 15% of the plots contained > 20%

cover of noxious and invasive weeds.

Noxious and invasive weed cover (weed cover) was also used as a factor in determining management emphasis rating. Fifty-two percent of the annual grassland plots contained < 5% weed cover, with 13% between 5-10% weed cover, 20% of the plots containing 10-20% weed cover and 15% of the plots contained > 20% weed cover.

Bromus tectorum, the most ubiquitous of these weeds, was found in every plant community in each vegetative alliance in the annual grasslands, with a mean of 8% cover and 46% mean constancy among plant associations. Its cover and constancy were highest in the *Bromus hordeaceus-Aira caryophyllea/Erodium, Bromus hordeaceus-Aira caryophyllea/ Dichelostemma capitatum*, and *Bromus hordeaceus-Bromus tectorum-Aira caryophyllea* plant association, with 10-19% cover within and 60-100% constancy among these plant associations.

Taeniatherum caput-medusae was found in 9 (60%) of the 15 plant communities, with mean cover of 14% and mean constancy of 38%. It was most common and abundant in the *Bromus hordeaceus-Taeniatherum caput-medusae/Erodium botrys, Bromus hordeaceus*-Annual grass/ *Hemizonia congesta*, and *Cynosurus echinatus-Bromus hordeaceus-Taeniatherum caput-medusae* plant associations, with 6–26% cover within and 71-100% constancy among plant associations.

Centaurea solstitialis was most abundant in the *Phalaris aquatica-Bromus hordeaceus/Centaurea solstitialis* plant association, with 15% cover in 100% of the plots sampled. It was also found in 50% of the plant associations in both the *Bromus hordeaceus* and *Cynosurus echinatus* alliances, with 25% averageconstancy and a range of 1-55% cover, averaging 9% within plant associations.

Hypericum perforatum was found in 8 (53%) of the 15 grassland plant associations, with mean cover of 3% and mean constancy of 40% among plant associations. It was most common in the *Cynosurus echinatus/ Hemizonia congesta-Madia* spp. plant association with 1% cover and 80% constancy.

Less common noxious and invasive weeds encountered in the annual grasslands included *Bromus madritensis* ssp. *rubens*, *Centaurea melitentsis, Cirsium vulgare, and Mentha pulegium.*

Bromus madritensis ssp. *rubens* was found in 7 (54%) of the plant associations in the *Bromus hordeaceus* and *Cynosurus echinatus* alliances, with 5% mean cover and 25% mean constancy among associations. It was

most common in the *Bromus hordeaceus-Aira caryophyllea/Dichelostemma capitatum* plant association with 7% cover and 41% constancy.

Cirsium vulgare was found in one plot in the *Cynosurus echinatus/ Lagophylla*/Rock plant association at 1% cover, and in 2 of 17 plots in the *Bromus hordeaceus-Limnanthes douglasii-Trifolium* plant association at 2% cover. *Centaurea melitensis* was encountered in one plot in the *Cynosurus echinatus-Bromus hordeaceus-Taeniatherum caput-medusae* plant association at 1% cover. One percent cover of *Mentha pulegium* was found in one plot in the *Cynosurus echinatus-Bromus hordeaceus-Bromus tectorum* plant association. Each of these plots was located on the Mad River Ranger District of the Six Rivers National Forest.

Noxious and invasive weeds noted by district personnel in the annual grasslands but not found in the plot data supporting this guide include *Carduus acanthoides*, *Cirsium arvense,* the knapweeds, *Centaurea diffusa* and *Centaurea maculosa*, and the goat grasses, *Aegilops cylindrica* and *Aegilops truncialis*.

Management emphasis on noxious and invasive weeds focuses on eradication of small infestations and long-term assault on larger infestations with the goal of control and eventual elimination. Control is influenced by the biology of the weed, its growth stage and physical situation, weather conditions, soil type, the timing of treatment and the method used. A single control method is rarely effective by itself. "Cumulative stress," a combination of mutually reinforcing treatments that together work to weaken the population is recommended. Where more than one noxious and invasive weed species inhabit an area, timing of treatments is even more important to ensure that what reduces the abundance of one does not stimulate the increase of the other.

Proposed Treatment Methods To Achieve Improved Ecological Conditions

The treatments proposed in this section are aimed at improving or maintaining the ecological conditions on our Northern Province rangelands. They fall into five categories:

1. maintaining the productivity of the soil:
2. reducing material deposition into stream channels:
3. maintaining high water quality:
4. restoring and maintaining native or naturalized species diversity and
5. controlling noxious and invasive weeds weeds.

Maintaining the productivity of the soil involves preventing erosion, compaction and loss of soil organic matter. Soil loss through erosion should not exceed the rate of soil formation (1 ton/acre/year). This can be

accomplished by maintaining sufficient soil cover of grasses, forbs and thatch to prevent accelerated soil erosion. Once bare soil and/or surface rock and gravel cover reaches or exceeds 20%, the allotment or portion of the allotment needs to be rested until maximum sustainable cover is achieved. This may require permanent withdrawal from grazing in the case of plant associations that are unlikely to be able to maintain soil cover. Examples of this in the *Cynosurus echinatus* alliance include the *Cynosurus echinatus-Bromus hordeaceus-Bromus tectorum* plant association where 62% of the plots have between 21-58% bare ground + surface gravel and rock, and the *Cynosurus echinatus/Lagophylla* spp.*//Rocky* plant association where 67% of the plots have between 35-95% bare ground + surface gravel and rock. The high amount of surface gravel and rock appear to indicate heavily eroded surfaces that will require extended time for recovery. Although surface gravel and rock cover is now arming the surface from sheet erosion, it is likely that the remaining bare ground in these types will continue to erode until sufficient soil cover is achieved. It also indicates that nearly 2/3 of the plots in these types may not be capable of producing sufficient forage to support livestock grazing.

In comparison, five of the six plant associations in the *Bromus hordeaceus* alliance contained plots with high bare ground, and many also had moderate to high surface gravel and rock. These plant associations included: 1) the *Bromus hordeaceus-Aira caryophyllea/Erodium* spp. plant association with 55% of the plots with 22-50% bare ground, surface gravel and rock, 2) the *Bromus hordeaceus-Aira caryophyllea/ Dichelostemma capitatum* ssp. *capitatum* plant association with 41% of the plots with 20-60% bare ground, surface gravel and rock, 3) the *Bromus hordeaceus/Erodium* plant association with 30% of the plots with 22-36% bare ground, surface gravel and rock, 4) the *Bromus hordeaceus-Taeniatherum caput-medusae/ Erodium botrys* plant association with 44% of the plots with 20-60% bare ground, surface gravel and rock, and 5) the *Bromus hordeaceus-Bromus tectorum* plant association with 78% of the plots with 21-85% bare ground, surface gravel and rock. The *Bromus hordeaceus* alliance differed from the *Cynosurus echinatus* alliance in the significantly higher cover of bare ground over surface gravel and rock. This indicates that *Bromus hordeaceus* associations likely had higher surface cover protection in the past. It also suggests that the high frequency of bare ground compared to surface gravel and rock may be the earlier stages of erosion, and that continued erosion will lead to higher surface gravel and rock similar to the plant associations in the *Cynosurus echinatus* alliance.

Sensitivity to compaction was described earlier by soil type and is included in each plant association description. Treatment methods involve recognizing the types of soils that are subject to compaction and preventing livestock onset until the soils have dried sufficiently to prevent it. Soils with fine, fine-loamy and fine-silty textures in the great groups Haploxeralfs and Xerochrepts are rated as having a high sensitivity to soil compaction.

Early season grazing on these soils needs particular attention to soil moisture in order to avoid compaction. Soil porosity on these associations should be at least 90% of total natural porosity.

Maintaining soil organic matter involves maintaining sufficient residual dry matter (RDM) to prevent short or long-term nutrient cycle deficits. Soil organic matter should be maintained at 85% of natural conditions for the upper 12 inches of the soil

The curtailment of grazing has been suggested by some as a method of restoring native perennial dominance in our northern California grasslands. Several studies (Barry and Schlinger 1977, Foin and Hektner 1986, Saenz and Sawyer 1986, Arguello 1994) have documented increased cover of perennial grass species after curtailment of grazing. However, this increased cover was in non-native perennial species that appear to have reduced the overall diversity of native species. Clearly a different management approach is necessary to increase or maintain native species diversity on our grasslands. This section will describe a variety of methods that we believe could lead to maintenance or enhancement of native species diversity.

The use of prescribed burning in annual grasslands has shown promise in increasing native species cover. Arguello (1994) found that both spring and fall burning, in the Bald Hills of Redwood National Park in Northwest California, inhibited the spread of *Arrhenatherum elatius*. However, he also found that spring burning severely reduced cover of *Danthonia californica,* a native management emphasis species. York (1997) found that fall burning in the Sierra Nevada foothills appeared to reduce non-native species and increase native species diversity. Other evidence suggests that a mixture of spring or fall burning every 1-5 years is best.

Heady (1956) described the effects of accumulated thatch as reducing sites for seed germination, smothering living plants and reducing seed stalk formation. Saenz and Sawyer (1986) found greater perennial grass cover on sites grazed for a partial season when compared to sites that were grazed for a full season. They suggested that thatch cover inhibited annual species cover on their study sites as well.

More closely controlled grazing where livestock animals seasonally graze, with adequate time for regrowth prior to soil drying and death of annuals and summer dormancy of perennials, is necessary. Dormant-season grazing is not as critical as green/growing season grazing. The old grazing methodology of distributing livestock over much or most of the allotment, allowing continuous repeat grazing of the same areas season-long, does not promote the restoration of or maintain native species. Grazing plans need to be developed where scheduled use, which may vary from year to year, is imposed on the allotments. Permittees will need to practice herd

management practices including more riding and salting, in order to achieve the desired result. Exclusion of grazing, especially from the more productive grasslands would do more harm to extant natives than continued managed grazing.

Where sites are inherently of low productivity due to geologic or management history, and where surface rill erosion is apparent, exclusion of grazing may be the best management practice. Proactive restoration of such sites, including seeding of natives or late-seral (short-term succession) species, should be tried to develop restoration methodology. Where only depauperate non-native annuals occur on poorly producing sites, addition of fertilizers may be necessary to establish late-seral (short-term succession) grasses as a step to seeding native perennial grasses. Building soil organic matter on the surface and in the A horizon will be necessary on the most degraded sites prior to reintroduction of late-seral (long-term succession) species. During the final reintroduction step, grazing management will be necessary to make the light and water environment of natives, within a matrix of non-native grasses, conducive to long-term establishment. Managed livestock grazing will continue to have an important role in restoration of annual grasslands since elimination of non-native annual grasses is infeasible. Livestock have a role in managing competition among native and non-native grasses.

Noxious weed control strategies

Noxious weed control management strategies are proposed below for the primary noxious weeds in the annual grasslands of the Northern Province.

***Centaurea solstitialis*--Yellow Star-thistle:** Biological control using host-specific insects has shown promise as the most enduring control for large infestations of yellow star-thistle. Two insects, the hairy weevil (*Eustenopus villosus*) and the seedhead fly (*Urophora sirunaseva*) have shown success both in inhibiting yellow star-thistle reproduction and maintaining or increasing their own populations in Calfornia. Host-specific pathogenic fungi and viruses have show promise in greenhouse studies as potential bio-controls but have not been tested in the field. Other treatments used with varying degrees of success include herbicides (the use of which may impact other members of the community), controlled grazing with cattle or sheep during yellow star-thistle bolting stage, and burning in late spring before yellow star-thistle seed set but after grass associates have produced seed. These control measures are long-term, and a combination of mutually-reinforcing treatments may prove most effective in large infestations to keep the population under constant stress. Mowing of smaller infestations when the flower is in bud stage but before seeds have developed, repeated as necessary over the season, may eventually prove effective. Mowings left on the ground may provide enough shade to prevent seeds near the surface from germination. Small patches and satellite infestations should be completely removed and monitored over time for

recovery from the seedbank. Yellow star-thistle produces a large and long-lived seedbank, and the success of any control strategies will require long-term diligence and monitoring.

***Taeniatherum caput-medusae*--Medusahead:** Controlled burning in late spring when medusahead seeds are immature and associated annuals are dry, providing fuels for a light but intense fire, may arrest seed development. Heavy grazing of infested areas during the spring green stage before seedheads form, especially in areas where medusahead litter has previously been burned or grazed may reduce its cover, though medusahead is not a preferred forage. The most promising method may be restoration using the native perennial grass, squirreltail (*Elymus elymoides*). Squirreltail has been successfully established in medusahead-infested areas in Idaho from broadcast seeding over existing annual vegetation dominated by this weed. Use of herbicides has been shown to reduce medusahead numbers, but at the same time reduced the abundance of its native associates, *Stipa* and bluebunch wheatgrass *(Pseudoroegneria spicata)*, while markedly increasing the population of its noxious associate, cheatgrass. There are no known biological controls for medusahead. Small infestations should be completely removed and monitored over time for recovery from the seedbank.

***Bromus tectorum*--Cheatgrass:** Multiple treatments are advised for cheatgrass to keep the population under constant stress. These include 1) fall burning to destroy the seedcrop and expose the soil surface. Cheatgrass will not normally germinate without a cover of mulch or litter; 2) grazing timed to the period when seed heads have developed but are still green (too early will stimulate regrowth, too late, awns may be injurious to the grazer); and 3) reseeding with native perennials. The ultimate aim is to eliminate new seed production while both depleting the seed bank and encouraging perennial reintroduction. There are no known biological controls for cheatgrass. Small infestations should be completely removed before they become dominant and alter the water holding capacity of the soil surface.

***Bromus madritensis* ssp. *rubens*--Red Brome:** Information on the control of this species is limited, but it appears that because red brome is both shade-intolerant and shallow-rooted it is sensitive to plant competition and grazing pressures. Management efforts focus both on reducing the size of the seed source and on reintroduction of native perennials. Late fall burning may damage seedlings while encouraging the growth of perennial grasses, though poorly timed burning has been shown to dramatically increase red brome populations. Red brome is not competitive in vegetated sites and established natives will out-compete red brome seedlings.

***Hypericum perforatum*--St. John's wort:** Biological controls, including foliage (*Chrysolina hyperici* and *C. quadrigemina*) and root-boring beetles (*Agrilus hyperici*), have historically been successful in California in controlling St. John's wort.

Bromus hordeaceus Plant Association Vegetation Key

1a. Moist sites with *Limnanthes douglasii* the dominant forb present in the spring along with a variety of *Trifolium* spp.....

.....*Bromus hordeaceus/Limnanthes douglasii-Trifolium* spp.

1b. *Limnanthes douglasii* absent or not as above..... 2

2a. Sites located on the Six Rivers National Forest 3

3a. *Trifolium sp.* present and ≥ 5% cover.....

.....*Bromus hordeaceus-Aira caryophyllea/ Dichelostemma capitatum* ssp. *capitatum*

3b. *Trifolium sp.* absent or not as above..... 4

4a. *Aira caryophyllea* present and ≥ 5% cover, sites usually under 3600' elevation.....*Bromus hordeaceus-Aira caryophyllea/Erodium* spp.

4b. *Aira caryophyllea* absent or not as above..... 5

5a. *Bromus tectorum* present and ≥ 5% cover, and *Taeniatherum caput-medusae* present and < 5% cover, slopes usually >25%.....*Bromus hordeaceus-Bromus tectorum*

5b. Not as above..... 6

2b. Sites located on the Mendocino National Forest 6

6a. *Taeniatherum caput-medusae* present and ≥ 2% cover.....

.....*Bromus hordeaceus-Taeniatherum caput-medusae/ Erodium botrys*

6b. *Taeniatherum caput-medusae* absent or not as above.....7

7a. *Dichelostemma multiflorum* and *Grindelia camporum* present..... *Bromus hordeaceus/Dichelostemma multiflorum-Grindelia camporum*

7b. Avena fatua present.....*Bromus hordeaceus/Erodium* sp.

Note: Check plant association comparison tables for likely type and validate with environment comparison.

Cynosurus echinatus Plant Association Vegetation Key

1a. Tarweeds, *Hemizonia congesta* ssp. *luzulaefolia and Madia* spp. dominate forb layer.....

Cynosurus echinatus/Hemizonia congesta ssp. *luzulaefolia-Madia elegans*

1b. *Hemizonia congesta* ssp. *luzulaefolia or Madia* spp. absent or not as above..... 2

2a. *Lagophylla* sp. *present*.....*Cynosurus echinatus/Lagophylla* spp. //Rocky

2b. *Lagophylla* sp. absent..... 3

3a. Sites above 3300 feet and *Bromus hordeaceus* and *Bromus tectorum* usually present.....

.....*Cynosurus echinatus-Bromus hordeaceus-Bromus tectorum*

3b. *Bromus hordeaceus* or *Bromus tectorum* absent or elevation less than 3300 feet..... 5

4a. *Taraxacum officinale* present..... 5

5a. Site is located on the Lower trinity Ranger District, *Limnanthes* sp. usually absent.....
Cynosurus echinatus-Bromus hordeaceus-Avena fatua

5b. Not as above..... 6

6a. *Bromus diandrus* present, site on the Mad River Ranger District

.....Cynosurus echinatus-Bromus hordeaceus/Taraxacum officinale

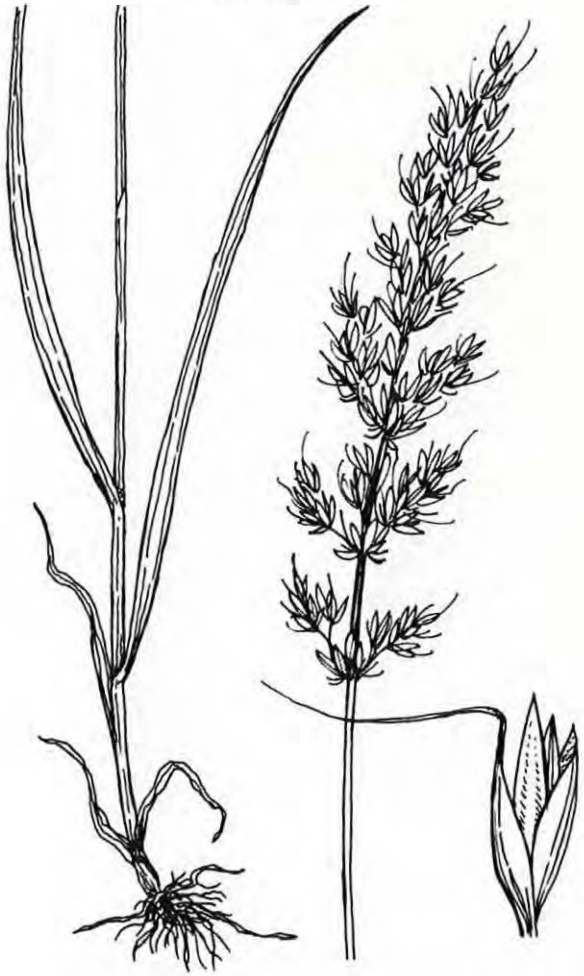
6b. *Bromus diandrus* absent or site not as above..... 7

4b. *Taraxacum officinale* absent..... 7

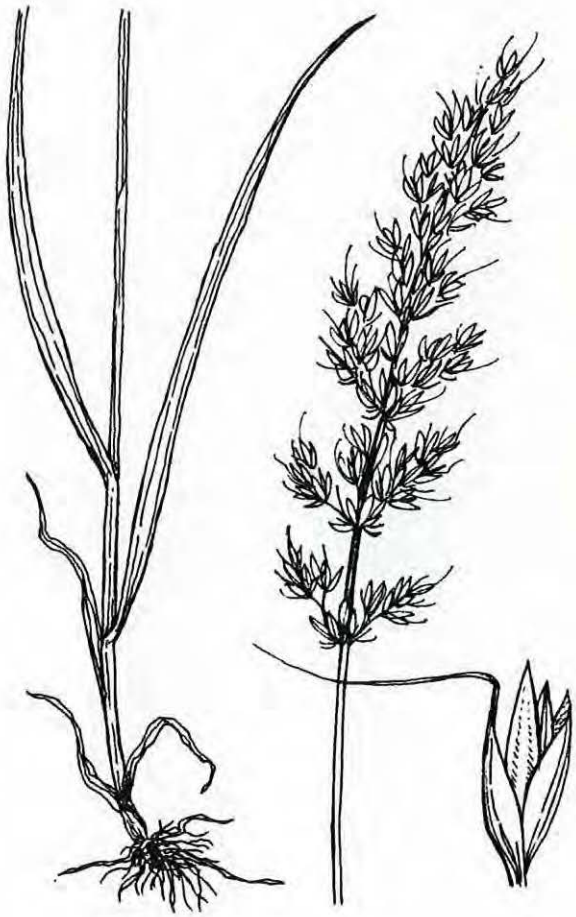
7a. *Trifolium* spp. and *Taeniatherum caput-medusae* usually present, sites on Mad River Ranger District.....*Cynosurus echinatus-Bromus hordeaceus-Taeniatherum caput-medusae*

7b. *Trifolium* spp. absent or not as above.....check plant association comparison tables for likely type and validate with environment comparison.

Arrhenatherum elatius
(Tall Oatgrass)
Alliance



Plant Association: ***Arrhenatherum elatius-Cynosurus echinatus/ Dichelostemma capitatum* var. *capitatum***
Tall Oatgrass-Hedgehog-dogtail/Bluedicks
EDP Code: **AREL3-CYEC/DICAC5 Association**
EcoCode: **GATOHD01**



Indicator Species

***Arrhenatherum elatius* (Tall Oatgrass):** This non-native, perennial grass is found on warm, moist, mid-elevation sites near the Pacific Ocean. It can easily dominate these sites and produce high amounts of thatch that may suppress native species. It greens up earlier in spring and remains green later into fall than most native perennial grasses. While it is palatable to livestock, they will not seek it out as a primary forage plant when other species are available. It grows on a wide range of soil textures and can be robust on productive sites, exceeding seven feet in height. It is one of the most drought-resistant grasses due to its deep root system.

Arrhenatherum elatius-Cynosurus echinatus/Dichelostemma capitatum var. *capitatum*
Tall Oatgrass-Hedgehog-dogtail/Bluedicks
AREL3-CYEC/DICAC5 Association, EcoCode: GATOHD01
Wildlife Habitat Relationships Type: Annual Grassland

SUMMARY TABLE
(Sample Size: 19)

Species Richness: 20.1
Shannon Index: 1.9

Ecological Status (Mean % Cover):

	Grasses	Forbs
Ann. Native	0.0	11.8
Ann. Exotic	52.7	2.1
Perenn. Native	3.1	6.2
Perenn. Exotic	38.4	11.8

Seral Status:

	R5 Grasses	1-5 Year	R5 Forbs
Early	90.3	4.2	24.1
Mid	2.5	0.0	4.6
Late	1.2	23.6	2.4

Environment:
Distance to Pacific Ocean: 28-30 mi.
Elevation: 2680-3800 ft.;
Aspect: West, East;
Slope: 5-35%;
Slope Position: Middle 1/3, Ridgetop;
Micro-relief:
Horizontal: undulating, linear, convex;
Vertical: undulating, convex;
Bare ground: 0-8%;
Surface Rock: 0-5%;
Litter Cover: 70-99%

Soils:
Pit Depth: 26-40+ in.;
AWC: 1.9-3.4 in.;
Parent Material: Sandstone;
A Horizon:
Coarse Fragments: 10-50%;
Textures: GL, SIL, L, GCL;
Clay content: 20-28%;
Thickness: 5-34 in.;
Surface pH: 5.7-7.0;
Depth to Argillic Horizon: 13 inches

		% COVER RANGE	MEAN	CON
Tree Overstory Layer				
None				
Tree Understory Layer				
None				
Shrubs				
TODI	*Toxicodendron diversilobum*	0-10	5	16
Forbs				
LOMI	*Lotus micranthus*	0-50	10	84
ACMI2	*Achillea millefolium*	0-8	3	84
RUAC	*Rumex acetosella*	0-8	2	84
DICAC5	*Dichelostemma capitatum* ssp. *c.*	0-1	1	84
LIBI5	*Linum bienne*	0-5	2	79
PLLA	*Plantago lanceolata*	0-8	2	63
TAOF	*Taraxacum officinale*	0-8	2	63
VIAMA	*Vicia americana* var. *americana*	0-2	2	63
CHPO3	*Chlorogalum pomeridianum*	0-2	1	63
MAOR3	*Marah oreganus*	0-5	2	53
LOMAT	*Lomatium* sp.	0-2	1	42
RAOC	*Ranunculus occidentalis*	0-2	1	42
PTAQP	*Pteridium aquilinum* var. *pubescens*	0-15	6	37
LUBI	*Lupinus bicolor*	0-3	1	37
CEGL2	*Cerastium glomeratum*	0-1	1	32
SIMA2	*Sidalcea malvaeflora*	0-5	2	26
GALIU	*Galium* sp.	0-1	1	26
ERCI6	*Erodium cicutarium*	0-8	3	21
CYGL	*Cynoglossum grande*	0-2	2	21
GNPU2	*Gnaphalium purpureum*	0-2	2	21
MEPO3	*Medicago polymorpha*	0-3	2	21
TRMA2	*Trifolium macrei*	0-2	2	21
Total Forb Cover		8-99	31	100
Graminoids				
AREL3	*Arrhenatherum elatius*	2-70	37	100
CYEC	*Cynosurus echinatus*	2-75	28	100
BRHO2	*Bromus hordeaceus*	0-75	18	89
AICA	*Aira caryophyllea*	0-15	4	89
LUCO6	*Luzula comosa*	0-4	1	53
AVFA	*Avena fatua*	0-25	6	47
BRCA5	*Bromus carinatus*	0-3	2	32
POPR	*Poa pratensis*	0-5	2	32
JUNCU	*Juncus* sp.	0-1	1	21
Noxious Weeds				
BRTE	*Bromus tectorum*	0-15	15	5
Total Graminoid Cover		15-99	94	100

PHYSICAL AND BIOLOGICAL ENVIRONMENT

Distribution/Setting:

This plant association was found in the Central Franciscan Subsection in the northern portion of the Northern California Coast Ranges Section of the National Hierarchy. Sites were located on the Lower Trinity Ranger District of the Six Rivers National Forest. Mean distance to the Pacific Ocean was 29.0 miles, lowest of all annual grassland types. It ranged from 28.5 to 30.2 miles inland.

Elevation averaged 3143 feet and ranged from 2680 to 3800 feet. Mean annual precipitation averaged 77 inches and was the highest of all annual grassland types. Slopes were moderately steep, averaging 19% and ranged from 5-35%. Aspects were mainly west and east facing. Mean annual radiation index was a relatively warm .500.

Sites were located primarily in the middle 1/3 slope and ridgetop positions. Horizontal and vertical micro-relief were undulating, convex and linear.

Soil Summary:

Soils in this type were mesic (100%), deep (79%) and moderately deep (21%). Soil drainage class was well-drained. Soils formed in colluvium and residuum from sandstone sedimentary rock. The litter layer had an average thickness of 0.4 inches at 86% cover, highest of all annual grassland types. Bare ground averaged 2% and ranged from 0-8%. Surface rock and gravel averaged 3% cover and ranged from 0-20%. The surface horizon averaged 13 inches thick and ranged from 5-34 inches thick. It had gravelly loam, silt loam, loam and gravelly clay loam textures. Surface colors were 10YR 3/2 (very dark grayish brown), 10YR 3/3 (dark brown) and 10YR 3/1 (very dark gray). Coarse fragment content averaged 18% and ranged from 8-40%. Clay content averaged 24% and ranged from 20-28%. Soil pH averaged 6.1, slightly acid, and ranged from 5.7-7.0.

The subsoils had gravelly clay loam, clay loam, very gravelly clay loam and silty clay loam textures. Subsoil colors were 2.5Y 3/2 (very dark grayish brown), 10YR 3/3 (dark brown), 10YR 4/5 (dark yellowish brown) and 10YR 3/1 (very dark gray). Subsoil coarse fragment content averaged 25% and ranged from 10% to 60%. Subsurface clay content averaged 29% and ranged from 23% to 37%. Subsurface pH averaged 6.4, slightly acid, and ranged from 6.0 to 7.0. The soils were 33% skeletal. Soil AWC averaged 2.8 inches and ranged from 1.9 inches to 3.4 inches. The soils were classified into the subgroups Pachic Xerumbrepts, Dystric Xerochrepts and Ultic Haploxeralfs.

Argillic horizons were a minor component (11%) in this type. Depth to argillic varied from 27 to 29 inches and averaged 28 inches deep. This depth is not likely to influence moisture conditions or rooting depth. In addition, the close proximity to the Pacific Ocean along with the cooler annual temperature and higher elevation sites further contribute to moister conditions. These factors contribute to the highest overall vegetation cover in the annual grassland type.

Vegetation Summary:

Total vegetation cover was very high (98%) and was dominated by grasses (94%). The tree layer was absent. Poison oak (*Toxicodendron diversilobum*) dominated the low cover of the shrub layer (5%) in the three sites that it was present. The moderate cover (31%) of the very diverse forb layer generally contained small-flowered lotus (*Lotus micranthus*) in association with common yarrow (*Achillea millefolium*), sheep sorrel (*Rumex acetosella*) and bluedicks (*Dichelostemma capitatum* ssp. *capitatum*). Tall oatgrass (*Arrhenatherum elatius*, 37%) and hedgehog-dogtail (*Cynosurus echinatus*, 28%) dominated the grass layer with soft chess (*Bromus hordeaceus*, 18%) and silver hairgrass (*Aira caryophyllea*, 4%) as frequent associates.

Species Richness:

Mean species richness was 20.1 species/plot, while Shannon diversity index was 1.9. Native grass species diversity was 1.4 species/plot. Diversity appears to have been dramatically affected by non-native grass competition, in particular the shading capability of *Arrhenatherum elatius*. For example, 11% of the 19 plots sampled in this type had no native grasses while 53% had only one native grass species present. Non-native grasses dominated the grass layer with an average of 5.1 species/plot. Forb species diversity was high with an average of 9.2 native species/plot and 4.2 non-native species/plot.

Ecological Status:

This type had the second highest mean grass cover (94%) of all annual grassland types. Grass cover was split between annual species (53%) and perennial species (41%). Perennial grass cover was the highest of all annual grassland types. All of the annual grass cover was made up of non-native species (53%). Perennial grass cover was also primarily made up of non-native species (38%). Only one of the 19 plots contained > 10% native perennial grass cover.

The grass layer seral status (long-term) points toward the dominance of cover in early seral species (90%), with low cover in mid-seral species (3%) and late seral species (1%). None of these plots had > 10% cover of mid or late seral species.

In the short-term (1-5 years) the overall species composition indicates a lack of recent disturbance from grazing and fire. High disturbance species had low cover (4%), medium disturbance species were absent and low disturbance species had relatively high cover (24%), consisting of tall annual grasses. Historic impacts from cattle grazing appear to have been higher, as indicated by low (1%) cover of late seral species, and further supported by the fact that cover of high disturbance species (4%) is far below the cover of early seral species (90%). This indicates that with more intensive grazing management or use of fire an improvement in short-term and eventually long-term ecological status could be realized.

Forb cover was among the lowest in the annual grassland type (31%) and was split between annual species (14%) and perennial species (17%). This low cover is likely due to the high cover, tall stature and large amount of organic matter produced by *Arrhenatherum elatius* and its ability to suppress the other species

around it. Forb cover differed substantially from the grass layer with 12% of the annual forb cover and 11% of the perennial forb cover being made up of native species. Fifty-eight percent of the plots had > 20% cover of native forbs, and 16% had > 40% cover of native forbs.

The long-term seral status of forb species also showed an unbalanced composition. It included 24% mean cover of early seral forb species, 5% cover of mid and 2% late seral species. The seral status in this type was so poor that only one plot had > 10% cover of mid seral forbs.

Management Emphasis Rating:

The management emphasis rating for this type was generally low based on environment and disturbance related species. This is misleading due to the high cover of the non-native perennial grass, *Arrhenatherum elatius* (AREL3). When long-term seral status is evaluated we can clearly see an unbalanced system in need of high management emphasis to reduce this non-native species.

Site Potential:

This type contains a host of native perennial species of low constancy and cover. These include *Bromus carinatus, Danthonia californica, Elymus glaucus, Festuca californica, Festuca occidentalis, Juncus* spp., *Luzula comosa* and *Achnatherum lemmonii.* These species can be considered as remnants of the past community and should be considered as long-term restoration objectives. Evidence from the Bald Hills of Redwood National Park suggest that *Danthonia californica* was a prominent member of the pre-European native plant community.

Closely Related Types:

The *Arrhenatherum elatius-Cynosurus echinatus/Dichelostemma capitatum* type is nested within the openings of the *Quercus kellogii-Quercus garryana/ Arrhenatherum elatius* type in the northern portion of the annual grasslands range. It is also found in close proximity to the *Cynosurus echinatus-Bromus hordeaceus-Avena fatua* type. This latter type may represent an earlier stage of AREL3 colonization and invasion with its lower abundance of this species. Revisiting plots of both types could go a long way in understanding the temporal trends in *Arrhenatherum elatius* dominance. The highly productive *Cynosurus echinatus-Bromus hordeaceus-Avena fatua* type is found within the same general range of environment parameters. The types differ in warmer aspects and radiation index along with the higher clay content and shallower depth to the argillic horizon found in the latter type.

Noxious Weeds:

High cover of the Cal-EPPC List A-1 noxious weed, cheatgrass (*Bromus tectorum,* 15%) was found in one plot in this plant community.

MANAGEMENT IMPLICATIONS:

In order to alter species composition on these sites AREL3 cover will have to be reduced. The tall stature of this plant combined with the high amount of organic material it produces leads to shading and suppression of associated species. The use of prescribed fire in fall followed by controlled spring grazing would likely favor

other species such as *Danthonia californica* and lead toward an improved short-term and long-term species composition.

Evidence worldwide indicates that AREL3 is relatively palatable to livestock. However, rumen content analysis for deer and elk in Redwood National Park indicates no use. Removal of livestock allows AREL3 to expand its dominance to an increasing degree over time. The palatability of AREL3 to livestock, deer and elk would be much improved following fire and the palatability would remain higher with grazing use. However, fire would need to be used periodically on an ongoing basis to manage AREL3 abundance. It is unlikely that grazing alone could be used to control or reduce AREL3 abundance because alternative forages of higher palatability are present in the community.

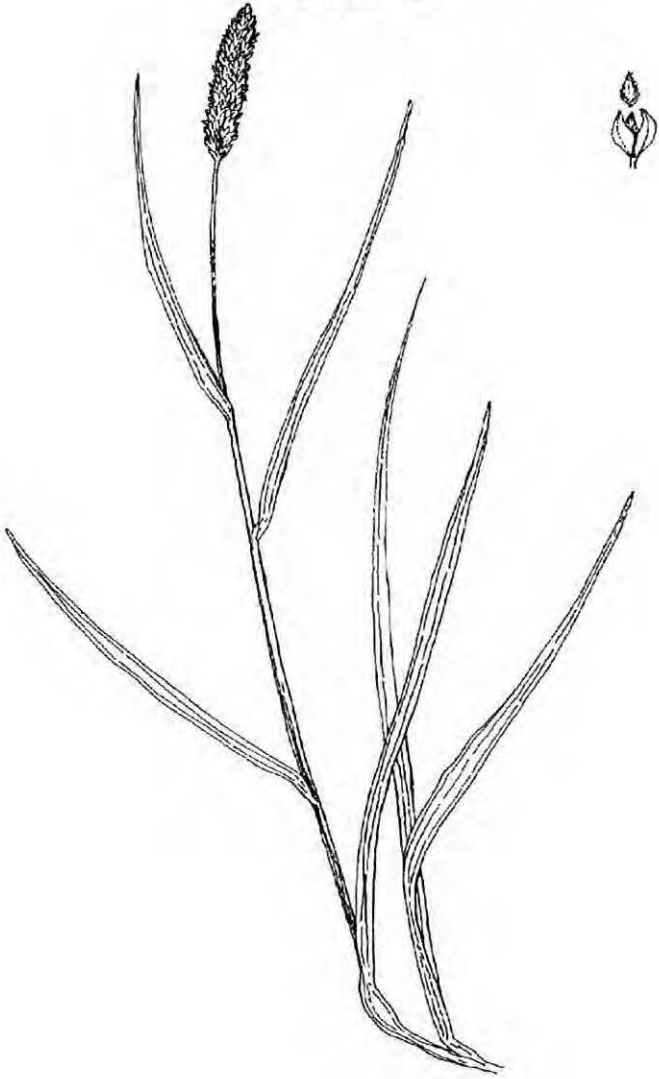
The weedy, annual grass *Cynosurus echinatus* is competitive with desirable native perennial grasses and other non-native annual grasses. Grazing management designed to increase native perennials will over time reduce abundance of *Cynosurus echinatus*. The presence of rank AREL3 plants on the site also would tend to focus grazing away from AREL3 dominated sites. Given the unpalatable inflorescence of *Cynosurus echinatus*, grazing prior to heading would have the greatest potential to reduce its abundance. A grazing plan using fire and grazing in combination has the greatest potential to improve the productivity and diversity of the community.

Infestations of *Bromus tectorum* are best addressed by subjecting the population to a combination of treatments to keep it under constant stress, each treatment reinforcing the others. These include: 1) prescribed burning in summer/ fall to destroy the seed crop; 2) carefully timed grazing; 3) reseeding with native perennials to provide competition; and 4) herbicides. There are no known biological controls. The aim is to eliminate new seed production and deplete the existing seed bank, and then develop management practices that deter re-infestation. Any eradication program should be expected to be long term, as noxious weeds have a large seed bank that will allow the population to re-establish itself for several years.

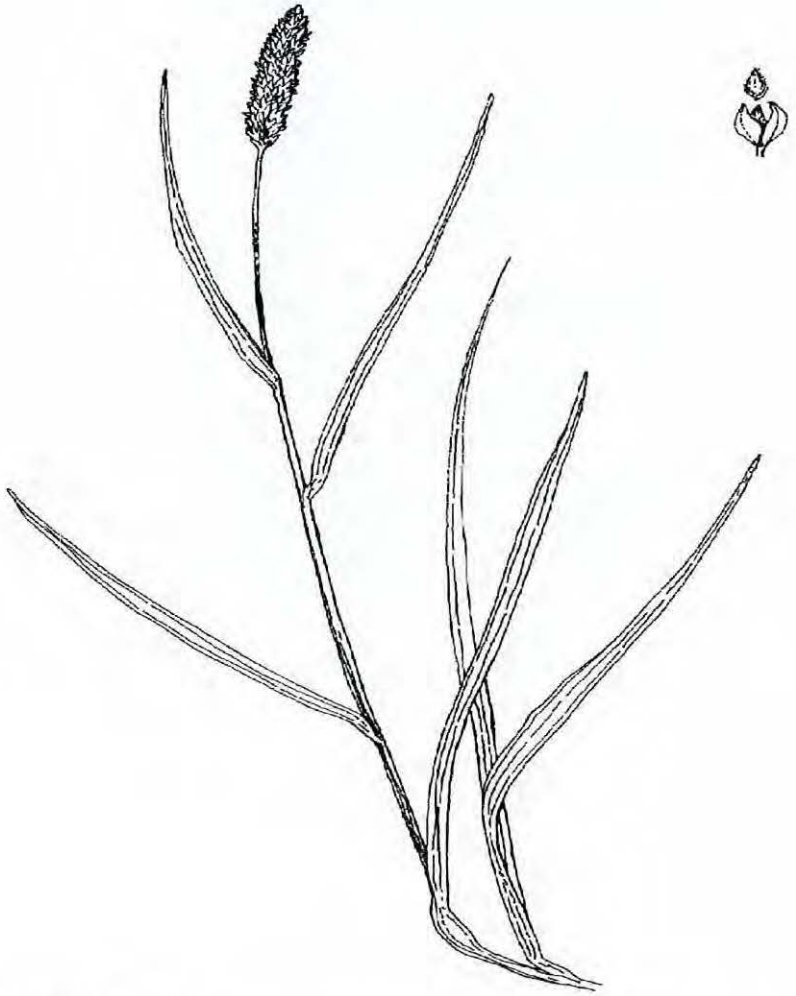
The abundance of native species is so low that management aimed solely at them would be of limited success in the short-term. Management to increase *Bromus hordeaceus* and *Avena fatua* would be preferable to the current situation. Spring burning may be more effective than fall burning to control AREL3 but detrimental effects on *Danthonia californica* would need to be considered. Post-burn grazing management could be used to reduce AREL3. Burns every three to four years followed by early grazing on new growth would reduce shading effects on non-natives and improve seedling establishment of native grasses.

Fifty percent of the plots in this type have soils rated as having a high sensitivity to compaction. The dominance of tall annual grasses does not indicate a compaction problem for the community. The management discussed above, including moderate seasonal grazing, would not be expected to produce compacted soils.

Phalaris aquatica
(Harding grass)
Series



Plant Association: ***Phalaris aquatica-Bromus hordeaceus/ Centaurea solstitialis***
Harding grass-Soft Chess/Yellow Star-thistle
EDP Code: **PHAQ-BRHO2/CESO3 Association**
EcoCode: **GAHGSC01**



Indicator Species:

***Phalaris aquatica* (Hardinggrass):** This drought tolerant, non-native, long-lived perennial bunchgrass was planted on type-converted chaparral sites in an attempt to increase forage for livestock. It is highly palatable and nutritious early and can withstand heavy grazing. It was found on low elevation, inland sites in the southern portions of the Northern Province.

Phalaris aquatica-Bromus hordeaceus/Centaurea solstitialis
Hardinggrass-Soft Chess/Yellow Star-thistle
PHAQ-BRHO2/CESO3 Association, EcoCode: GAHGSC01
Wildlife Habitat Relationships Type: Annual Grassland

SUMMARY TABLE
(Sample size: 7)

Species Richness: 17.6
Shannon Index: 1.91

Environment:
Distance to the Ocean: 57-62 mi.
Elevation:1950-2400 ft.;
Aspect: West, North;
Slope: 12-22%;
Slope Position: Middle 1/3, upper 1/3;
Micro-relief:
Horizontal: linear, concave;
Vertical: linear;
Bare ground: 1-2%;
Surface Rock: 1-6%;
Litter Cover: 5-75%

Ecological Status (Mean % Cover)

	Grasses	Forbs
Ann. Native	4.0	6.0
Ann. Exotic	28.0	21.0
Perenn. Native	2.0	3.0
Perenn. Exotic	40.0	0.0

Seral Status:	R5 Grasses	1-5 Year	R5 Forbs
Early	72.0	7.0	24.1
Mid	0.0	2.0	3.9
Late	0.3	20.3	1.4

So
Pit Depth: 45-60 in.;
AWC: 2.4-2.8 in.;
Parent Material: rhyollite;
A Horizon:
Coarse Fragments: 15-25%;
Textures: cosl;
Clay content: 18-24%;
Thickness: 8-12 in.;
Surface pH: 6.8-7.2;
Depth to Argillic Horizon: 8-12 in.

		% COVER RANGE	MEAN	CON
Tree Overstory Layer				
None				
Tree Understory Layer				
None				
Shrubs				
CECU	*Ceanothus cuneatus*	0-5	3	71
TODI	*Toxicodendron diversilobum*	0-5	4	29
Forbs				
CLARK	*Clarkia* sp.	0-1	1	71
GALIU	*Galium* sp.	0-2	1	71
TRDU2	*Trifolium dubium*	0-13	6	57
ERODI	*Erodium* sp.	0-1	1	57
YAMI	*Yabea microcarpa*	0-5	3	43
CEGL2	*Cerastium glomeratum*	0-2	2	43
CAAT25	*Castilleja attenuata*	0-1	1	43
CREPI	*Crepis* sp.	0-1	1	43
CYGR	*Cynoglossum grande*	0-1	1	43
GEMO	*Geranium molle*	0-1	1	43
CATO	*Calochortus tolmei*	0-2	2	29
DICAC5	*Dichelostemma capitatum* ssp. *c.*	0-1	1	29
MARAH	*Marah* sp.	0-1	1	29
SABI3	*Sanicula bipinnatifida*	0-1	1	29
ZIGAD	*Zigadenus* sp.	0-1	1	29
Noxious Weeds				
CESO3	*Centaurea solstitialis*	1-35	14	100
Total Forb Cover		5-45	30	100
Graminoids				
PHAQ	*Phalaris aquatiica*	20-60	40	100
BRHO2	*Bromus hordeaceus*	3-30	17	100
KOMA	*Koehleria macrantha*	0-5	2	88
BRDI3	*Bromus diandrus*	1-15	5	71
AICA	*Aira caryophyllea*	0-18	12	57
VULPI	*Vulpia* sp.	0-20	10	57
Noxious Weeds				
BRMAR	*Bromus madritensis* ssp. *rubens*	0-2	1	71
Total Graminoid Cover		40-85	74	100

PHYSICAL AND BIOLOGICAL ENVIRONMENT

Distribution/Setting:
This plant association is found on sites converted from chaparral vegetation. It was found in the Eastern Franciscan Subsection in the southern portion of the Northern California Coast Ranges Section of the National Hierarchy. Sites were located on the Grindstone (Corning) Ranger District of the Mendocino National Forest. Mean distance to the Pacific Ocean was 60 miles, highest in the annual grassland category. It ranged from 57 to 62 miles inland.

Elevation averaged 2314 feet, lowest of the annual grassland types and ranged from 2300 to 2400 feet. Mean annual precipitation averaged 39 inches and was the lowest of all annual grassland types. Slopes were moderately steep, averaging 22% and ranging from 12-22%. Aspects were mainly west and north facing, with mean annual radiation index a relatively cool .288.

Sites were located primarily in the middle and upper 1/3 slope position with linear/ concave horizontal and linear vertical micro-relief.

These sites were type-converted chaparral vegetation for the multiple purposes of 1) fire control access along ridges by breaking up an otherwise expansive landscape of brush land to reduce wildfire hazard, 2) improving wildlife habitat especially for deer and quail, including access for hunters, and 3) providing for seasonal livestock grazing. The chaparral vegetation along ridgelines was crushed by chaining, ball-and-chain, and brush raking, then burned and seeded to harding grasses, orchard grasses, annual clovers and other species (none were native because the technology was unavailable at the time). Broadcast burning was also accomplished by crushing brush at the base of hillsides, followed by burning the next year under prescriptions that would cause the fire to spread from the desiccated crushed brush uphill into untreated brush on steeper slopes. The ridgelines served initially as fuel breaks to allow rotational prescribed burning in a landscape pattern favorable both for sustaining wildlife populations and management of fuel loads.

Soil Summary:
Soils in this type were found in the thermic (100%) temperature regime. Soil depth class was deep (100%) and well drained. They formed from rhyollite volcanic rock. The litter layer had an average thickness of 1.0 inches at 5% cover. Bare ground averaged 2% and ranged from (1-2%). Surface rock and gravel averaged 5% cover and ranged from 2-6%. The surface horizon averaged 10 inches. It had coarse sandy loam texture. Surface color was 7.5YR 4/3 (dark brown), with a coarse fragment content average of 20%. Clay content averaged 20% and ranged from 18-24%. Soil pH averaged 7.0, neutral.

The subsoils were gravelly clay loam textures. Subsurface color was 7.5YR 4/6 (yellowish red), with a coarse fragment content average of 12%. Subsurface clay content averaged 28% and ranged from 24% to 33%. Subsurface pH averaged 6.8, neutral. The soils were 100% non-skeletal. Soil AWC averaged 2.6 inches and ranged from 2.4 inches to 2.8 inches. The soils were classified into the subgroup Ultic Argixerolls.

Argillic horizons were present on all plots in this type. Depth to argillic varied from 8 to 12 inches and averaged 10 inches deep. This depth is very likely to influence moisture conditions and rooting depth. In addition, the hot inland site conditions and upper 1/3 slope locations further contribute to drier conditions on these chaparral sites.

Vegetation Summary:
Total vegetation cover was 91% and was dominated by grasses (74%). The tree layer was absent. Low cover (3%) of buckbrush (*Ceanothus cuneatus*) represented the shrub layer. The moderate cover (30%) of the forb layer was dominated by yellow starthistle (*Centaurea solstitialis*) whose cover ranged from 1 to 35%. Its diverse associates commonly included western hedge-parsley (*Yabea microcarpa*), *Clarkia* species, bedstraws (*Galium* spp.), storksbills (*Erodium* spp.) and suckling clover (*Trifolium dubium*). Harding grass (*Phalaris aquatica*, 40%) dominated the grass layer. Soft chess (*Bromus hordeaceus*, 17%), prairie junegrass (*Koehleria macrantha, 2%*) and ripgut brome (*Bromus diandrus*, 5%) were its primary associates.

Species Richness:
Mean species richness was 17.6 species/plot, while Shannon diversity index was 1.9. Native grass species diversity was 1.0 species/plot. In all of the seven plots sampled in this type only one native grass species was present. Non-native grasses dominated the grass layer with an average of 3.5 species/plot. Forb species diversity was high with an average of 10.5 native species/plot and 3.4 non-native species/plot.

Ecological Status:
This type had moderate grass cover (74%) in comparison to the rest of the annual grassland types. Grass cover was split between annual species (32%) and perennial species (42%). Most of the annual grass cover consisted of non-native species (28%). Perennial grass cover was also primarily non-native species (42%).

The grass layer seral status (long-term) points toward the dominance of cover in early seral species only (72%). It is likely that chaparral species will eventually reestablish themselves and dominate the site unless prescribed fire is periodically used to reduce woody plant encroachment into these type-converted grasslands

The short-term disturbance status is somewhat improved. High disturbance cover (7%) was moderate and cover of medium disturbance indicator species was low (2%), while low disturbance species cover was moderate (20%). Forty-three percent of the plots had > 20% low disturbance species cover. This indicates that increased management emphasis could lead to an improvement in both the short-term and long-term successional status.

Forb cover was among the lowest in the annual grassland type (30%). Much of the forb cover was made up of noxious and invasive weeds. Forb cover was split between annual species (27%) and perennial species (3%). This differed substantially from the grass layer in which 4% of the annual forb cover and 3% of the perennial forb cover was made up of native species. None of the plots had > 20% cover of native forbs.

The long-term seral status of forb species also shows an unbalanced composition of seral stages. It included 24% mean cover of early seral forb species, 4% mean cover of mid seral and 1% late seral species.

Management Emphasis Rating:
The management emphasis rating for this type was high. This was due to high cover of noxious and invasive exotoc weeds, and the cover of high disturbance short-term indicator species.

Site Potential:
This type was site-converted from a chaparral community dominated by *Adenostoma fasciculatum* and *Ceanothus cuneatus* to an annual grassland community dominated by *Phalaris aquatica, Bromus hordeaceus and Bromus rigidus.* It currently contains the native shrub species, *Adenostoma fasciculatum, Ceanothus cuneatus and Holodiscus discolor*, a host of native forbs and two native grass species, *Koeleria macrantha and Vulpia microstachys.*

Closely Related Types:
This plant community is a grassland converted from the pre-existing chaparral plant association, *Adenostoma-fasciculatum-Ceanothus cuneatus* type.

Noxious Weeds:
From the CalEPPC List A1 noxious weed list, high cover of yellow star-thistle (*Centaurea solstitialis,* 14%) was found in all plots, and low cover of red brome (*Bromus madritensis* ssp. *rubens*, 1%) was found in 71% of the plots in this plant community.

MANAGEMENT IMPLICATIONS:

Both *Adenostoma fasciculatum* and *Ceanothus cuneatus* appear to be slowly reclaiming these sites. Management needs to decide if the existing *Phalaris aquatica-Bromus hordeaceus/Centaurea solstitialis* community is the desired future condition for these sites. If so, management emphasis needs to be placed on reducing shrub invasion. Livestock grazing, burning, and herbicide techniques and their combined use have been studied at the University of California, Hopland Field Station in Mendocino County, and techniques are available to maintain the grassland. Study plots at Hopland have not been invaded with star-thistle so extra measures would be needed to eradicate this weed.

The noxious weed, yellow star-thistle (*Centaurea solstitialis),* will require management emphasis in order to prevent its dominance on these sites. The use of California Conservation Corps crews to hand-pull and bag star-thistle each year could be a very effective eradication technique. If done before flowering, seed production is curtailed and the spines on the flower heads are not yet present, making handling much less painful. Burial in a land fill is a possible disposal mechanism. Such practices if carried out adequately over a 3-5 year period could fully eradicate the weed. Monitoring after that period could be done by local managers by pulling the few remaining individuals. This technique takes follow-through and commitment on the part of personnel or all efforts will be for naught. Intensive grazing or mowing strategies would not likely work since

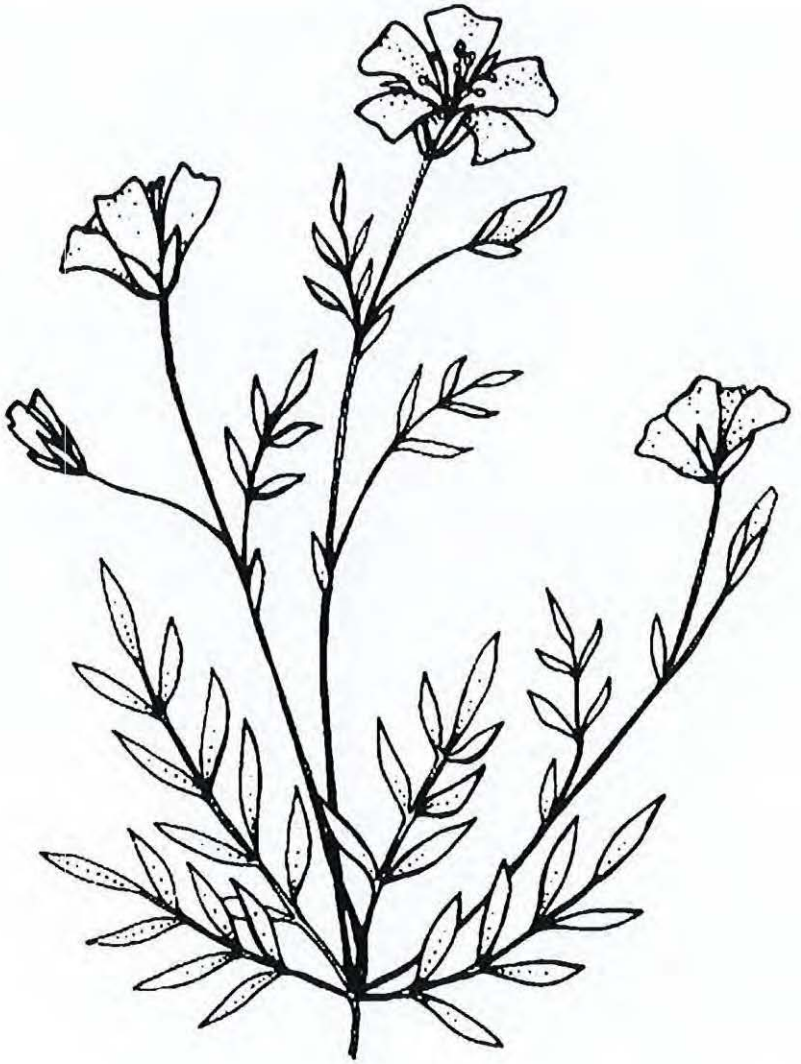
seed-producing plants would surely be missed and the re-infestation would continue

To reduce large infestations of yellow star-thistle, several controls have been utilized by land managers with varying success, the best success achieved when methods are used in combination. All are long-term endeavors that must be maintained over time. These include: 1) Biological control by means of the hairy weevil and/or seedhead fly; 2) Controlled grazing by cattle or sheep timed to specific preflowering stages of yellow star-thistle development; 3) Mowing timed to specific stages (preflowering) of yellow star-thistle development and repeated at least once per season; 4) prescribed burning in late spring timed to specific stage of yellow star-thistle development; and 5) herbicides.

The aim is to eliminate new seed production and deplete the existing seed bank, and then develop management practices that deter re-infestation. Any eradication program should be expected to be long term, as noxious weeds have a large seed bank that will allow the population to reestablish itself for several years.

Bromus hordeaceus (Soft Chess) Alliance

Plant Association: ***Bromus hordeaceus/Limnanthes douglasii-Trifolium*** **spp.**
Soft Chess/Douglas Meadowfoam-Clover
EDP Code: **BRHO2/LIDO-TRIFO Association**
EcoCode: **GASCFX01**



Indicator Species:

Limnanthes douglasii **(Douglas Meadowfoam):** This annual, native forb was found on moist-wet, concave, middle and lower 1/3 slope positions.

***Bromus hordeaceus/Limnanthes douglasii-Trifolium* spp.**
Soft Chess/Douglas Meadowfoam-Clover
BRHO2/LIDO-TRIFO Association, EcoCode: GASCFXO1
Wildlife Habitat Relationships Type: Annual Grassland

SUMMARY TABLE
(Sample size: 18)

Species Richness: 21.7
Shannon Index: 2.2

Environment:
Distance to the Ocean: 30.1-42.0 mi.;
Elevation: 1840-3560 ft. outlier 4320 ft.;
Aspect: Southeast, southwest;
Slope: 2-35%;
Slope Position: lower, middle 1/3;
Micro-relief:
  Horizontal: concave/undulating;
  Vertical: linear;
Bare ground: 0-12%;
Surface Rock: 0-7%;
Litter Cover: 0-12%, outlier 30%

Ecological Status (Mean % Cover):

	Grasses	Forbs
Ann. Native	0.5	34.3
Ann. Exotic	57.9	14.0
Perenn. Native	12.8	14.8
Perenn. Exotic	1.3	2.1

Seral Status:	R5 Grasses	1-5 Year	R5 Forbs
Early	59.0	20.7	31.0
Mid	5.6	0.11	3.6
Late	5.8	39.8	22.7

Soils:
Pit Depth: 27-60 in.;
AWC: 2.5-3.6 in.;
Parent Material: sandstone, siltstone;
A Horizon:
  Coarse Fragments: 4-10%, outlier 36%;
  Textures: SIL, CL, L;
  Clay content: 20-32%;
  Thickness: 4-16 inches;
Surface pH: 6.0-7.0;
Depth to Argillic Horizon: 5-16 inches

		% COVER RANGE	MEAN	CON
Tree Overstory Layer				
None				
Tree Understory Layer				
None				
Shrubs				
None				
Forbs				
LIDO	*Limnanthes douglasii*	1-70	18	100
TRIFO	*Trifolium* spp.	0-61	10	93
RAOC	*Ranunculus occidentalis*	0-20	5	61
CEGL2	*Cerastium glomeratum*	0-5	2	56
GEDI	*Geranium dissectum*	0-10	4	44
DICAC5	*Dichelostemma capitatum* ssp. *ca.*	0-1	1	33
MEPO3	*Medicago polymorpha*	0-25	13	28
PEKE	*Perideridia kelloggii*	0-30	7	28
HECOL	*Hemizonia congesta* ssp. *luzulaefolia*	0-15	6	28
ANAR	*Anagallis arvensis*	0-5	2	28
CRIN8	*Cryptantha intermedia*	0-3	2	28
RUCR	*Rumex crispus*	0-5	2	28
LODI	*Lomatium dissectum*	0-1	1	28
WYAN	*Wyethia angustifolia*	0-1	1	28
MIGU	*Mimulus guttatus*	0-2	2	22
TRHY3	*Tritelia hyacinthina*	0-1	1	22
Noxious Weeds				
CIVU	*Cirsium vulgare*	0-1	1	11
Total Forb Cover		15-80	65	100
Graminoids				
BRHO2	*Bromus hordeaceus*	2-70	25	100
CYEC	*Cynosurus echinatus*	0-35	9	78
HOMAG	*Hordeum marinum* ssp. *geniculatum*	0-65	21	72
AICA	*Aira caryophyllea*	0-20	5	61
POA	*Poa* sp.	0-10	4	53
BRDI3	*Bromus diandrus*	0-20	6	50
BRMI2	*Briza minor*	0-5	3	50
DACAA	*Danthonia californica* var. *americana*	0-25	8	28
AVBA	*Avena barbata*	0-3	2	28
Noxious Weeds				
BRTE	*Bromus tectorum*	0-2	2	28
TACA8	*Taeniatherum caput-medusae*	0-10	5	11
Total Graminoid Cover		20-85	72	100

PHYSICAL AND BIOLOGICAL ENVIRONMENT

Distribution/Setting:
This plant association was found in the Eastern Franciscan and Central Franciscan subsections in the north-central portion of the Northern California Coast Ranges Section of the National Hierarchy. Sites were located on the Mad River Ranger District of the Six Rivers National Forest and on the Covelo Ranger District of the Mendocino National Forest. Mean distance to the Pacific Ocean was 34.4 miles and ranged from 30.1-42.0 miles.

Elevation averaged 2718 feet, towards the low end of the *Bromus hordeaceus* alliance. It had a range of 1840 to 3560 feet with one outlier plot found at 4320 feet. Mean annual precipitation averaged 64 inches and fell toward the high end of the series. Slopes were moderately steep, averaging 21% and ranging from 2-35%. Aspects were southeast and southwest with a warm mean annual radiation index of .506. Aspect effects were moderated somewhat by slope micro-position and its related topographic shading.

Sites were located primarily in the middle and lower 1/3 slope positions with concave/ undulating horizontal micro-relief and linear vertical micro-relief. These factors lead water to flow though and collect here, making this the wettest type in the annual grassland type.

Soil Summary:
Soils in this type were thermic (100%), deep (62%) and moderately deep (38%). Soil drainage was somewhat poorly drained, moderately well and well drained. They formed in colluvium from the sedimentary rocks sandstone and siltstone. The litter layer had an average thickness of 0.2 inches at 6% cover. Bare ground averaged 7% and ranged from (0-12%). Surface rock and gravel averaged 2% cover and ranged from 0-7%. The surface horizon averaged 10 inches thick and ranged from 4-16 inches thick. It had silt loam, clay loam and loam textures. Surface colors were 10YR 3/1 (very dark gray), 2.5Y 3/2 (very dark grayish brown) and 2.5Y 5/2 (grayish brown). Coarse fragment content averaged 8% and ranged from 4-10%. Clay content averaged 25% and ranged from 20-32%. Soil pH averaged 6.6 (neutral) and ranged from 6.0-7.0.

The subsoils had gravelly clay loam, clay loam and very gravelly clay loam textures. Subsoil colors were 2.5Y 2/1 (black) and 10YR 4/3 (dark brown). Subsoil coarse fragment content averaged 25% and ranged from 5% to 66%. Subsurface clay content averaged 39% and ranged from 29% to 50%. Subsurface pH averaged 6.8, neutral and ranged from 6.3 to 7.3. The soils were 100% non-skeletal. Soil AWC averaged 3.1 inches for the top 20 inches and ranged from 2.5 inches to 3.6 inches with one outlier plot at 0.8 inches. The soils were classified into the subgroups Typic and Pachic Argixeroll and Pachic Haploxeroll.

Argillic horizons were the primary diagnostic horizon in 89% of the plots. This horizon usually leads to drier conditions that influence grass cover by restriction of rooting depth. In this case, average depth to the argillic horizon was 13 inches. The relatively shallow argillic horizon promotes subsurface flow down the hill-slope providing natural sub-irrigated conditions at all slope positions in this high rainfall regime, especially in the lower 1/3 slope positions. Soil colors exemplify these moist conditions with surface colors tending toward grays (reducing conditions) and subsurface colors tending toward black (high organic material, very slow breakdown). These moist conditions support the highest total vegetation cover in the *Bromus hordeaceus* alliance.

Vegetation Summary:
Total vegetation cover averaged 91% and consisted of grasses (72%) and forbs (65%). The tree and shrub layers were absent. The highly variable forb layer (over 105 species among sites) was dominated by meadowfoam *(Limnanthes douglasii,*

18%) and often included western buttercup *(Ranunculus occidentalis,* 5%), mouse-ear chickweed *(Cerastium glomeratum*, 2%) and a variety of clovers *(Trifolium* spp., 10%) including *Trifolium bifidum, Trifolium fucatum, Trifolium microdon, Trifolium wildenovii, Trifolium variegatum* and *Trifolium wormskoldii.* The grass layer was dominated by soft chess *(Bromus hordeaceus*, 25%), and often contained a high cover of mediterranean barley *(Hordeum marinum* ssp. *geniculatum*, 21%) and a moderate cover of hedgehog-dogtail *(Cynosurus echinatus*, 9%), silver hairgrass *(Aira caryophyllea*, 5%), little quaking grass *(Briza minor*, 3%) and ripgut brome *(Bromus diandrus*, 6%) among its very diverse associates (over 39 species among sites).

Species Richness:
Mean species richness was 21.7 species/plot, third highest in the annual grassland type. Shannon diversity index was 2.2, fourth highest in the annual grassland type. Native grass species diversity (1.7 species/plot) appears to have been particularly affected by the aggressive nature of non-native grasses and their ability to out-compete native species. For example, 29% of the 17 plots sampled in this type had no native grasses while an additional 29% had only one native grass species present. Conversely, non-native grasses dominated the grass layer with an average of 5.9 species/plot. In contrast, forb species diversity was reversed with an average of 10.2 native species/plot and 2.9 non-native species/plot.

Ecological Status:
The grass layer seral status (long-term) points toward the dominance of cover in early seral species (59%), with low cover in mid-seral species (6%) and late seral species (6%). Only twenty-three percent of these plots had > 10% cover of mid and late seral species.

In the short-term (1-5 years), the overall species composition is improving as indicated by the relatively high cover (40%) of low disturbance related tall annual grasses. This is likely related to reduced disturbance by cattle grazing as stocking rates have declined. Historical impacts of cattle grazing appear to have been higher as indicated by only 6% cover of late seral species. This is further supported by the fact that cover of high disturbace species (21%) is much below the presence of early seral plants (59%). This indicates that increased management efforts here could lead to an improvement in short-term and eventually long-term ecological status.

Forb cover (65%) in this association was the highest of all annual grassland plant associations. It was split between annual species (48%) and perennial species (17%). This differed substantially from the grass layer with 34% of the annual cover and 15% of the perennial cover being made up of native species. Eighty-eight percent of the plots in this type had > 20% cover of native forbs and 59% had > 40% cover of native forbs.

The long-term seral status of forb species shows a more balanced composition than that of the grass layer. It included mean forb cover of 31% early, 14% mid and 23% late seral species. Forty-one percent of the plots had > 20% cover of late seral species, while 29% had > 40% cover of late seral species.

Management Emphasis Rating:
The management emphasis rating for this type varied from low to high. This was due to the infrequent high bare ground, adequate litter cover, very low cover of noxious and invasive exotoc weeds, and high cover of low short-term disturbance indicator species. Further analysis at the plot level could identify opportunities for treatment of localized weed infestations to check their spread.

Site Potential:
This type contains a host of native perennial and annual grass and grasslike species of low constancy and cover. These include *Bromus carinatus, Carex densa, Carex*

praegracilis, *Danthonia californica*, *Deschampsia danthonioides*, *Deschampsia elongata*, *Eleocharis acicularis*, *Eleocharis macrostachys*, *Elymus glaucus*, *Juncus bufonius*, *Juncus confusus*, *Juncus effusus*, *Juncus patens*, *Luzula comosa*, *Melica* sp. *Poa secunda* and *Vulpia microstachys*. These species can be considered as remnants of the past community and should be considered as long-term restoration objectives. Current cover and constancy of *Danthonia californica* suggests that it was a prominent member of the native plant community.

Closely Related Types:
This type was usually found just upslope from the perennially wet *Juncus* spp.-*Bromus hordeaceus/Limnanthes douglasii-Trifolium* type. Conditions here are drier, particularly in late summer and fall.

Noxious Weeds:
Low cover of the CalEPPC List A1 noxious weed, yellow star-thistle (*Centaurea solstitialis*, 1%) was found on one plot on the Six Rivers. On the same list, bull thistle (*Cirsium vulgare*, 1%) was found on three Six Rivers plots and cheatgrass (*Bromus tectorum*, 2%) was found on five plots among both forests.

MANAGEMENT IMPLICATIONS:
No livestock grazing management studies have been published on California annual grassland under this high a precipitation regime. Excessively wet surface soil conditions for much of the year and loam textures make these soils highly subject to compaction by trampling. However, lack of gullying and terracing of slopes indicates that these soils are not highly subject to erosion.

Twenty-five percent of the plots in this type had soils rated as having a high sensitivity to compaction. Since these sites have been in livestock grazing allotments for many years, apparently livestock do not concentrate use in these types or compaction effects would be apparent. The moist site indicator species, Douglas meadowfoam, is not attractive to grazing use.

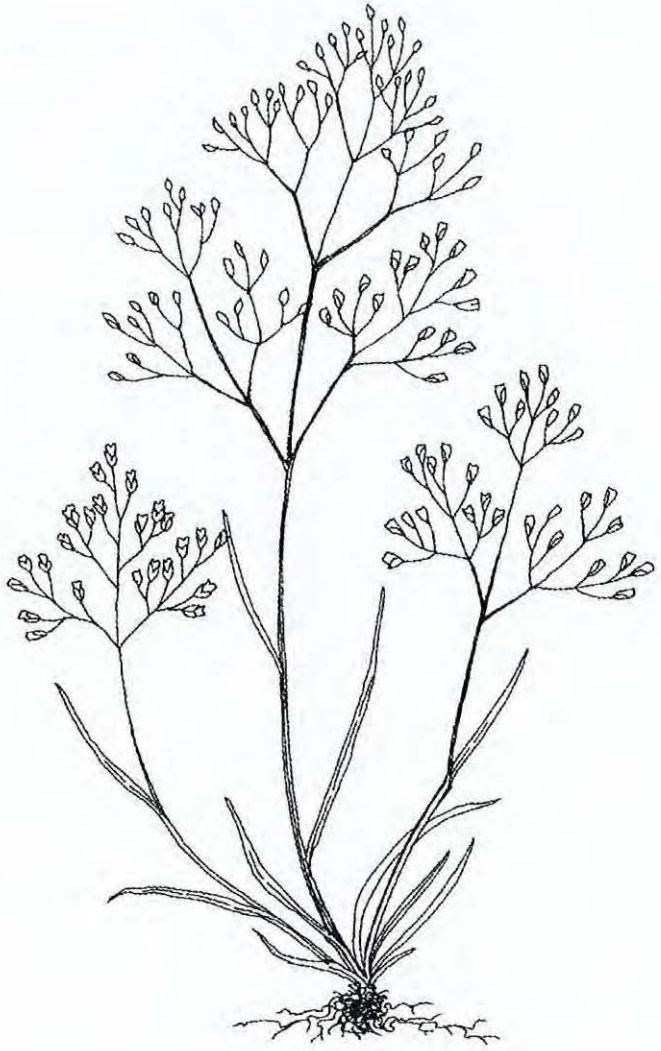
High cover of *Hordeum marinum* ssp.*geniculatum* usually indicates disturbance by trampling, especially in seasonally wet soils. This species is normally indicative of frequent disturbance by trampling. Cattle avoid this species from the boot stage of growth through senescence. Further observation is needed for this type to understand possible grazing effects since evidence available at this time is conflicting.

Presence of native perennial bunchgrasses, including the genera *Danthonia*, *Melica*, *Elymus*, *Deschampsia*, and *Poa* indicates possible remnant members of a formerly dominant community, but with the exception of *Deschampsia*, most site conditions appear too wet for healthy stands of these species except on localized knolls away from saturated soil.

If standard range readiness criteria were applied to these communities, only a very restricted, late grazing season (summer/fall) would be available most years due to wet surface soils.

Small infestations of yellow star-thistle and bull thistle should be completely eradicated, with monitoring in subsequent years to track re-infestation from the seed bank. New infestations of cheatgrass should likewise be dealt with before it becomes dominant and alters the water holding capacity of the soil surface. Again, hand-pulling of the limited number of star-thistle plants would be the preferred method of eradication.

Plant Association: ***Bromus hordeaceus-Aira caryophyllea/ Erodium*** **sp.**
Soft Chess-Silver Hairgrass/Storksbill
EDP Code: **BRHO2-AICA/ERODI Association**
EcoCode: **GASCFX02**



Indicator Species:

Aira caryophyllea **(Silver Hairgrass):** This non-native, annual grass is an indicator of dry, degraded conditions. It is most often found on upper 1/3 slopes or spur ridges with convex slope shapes. Where it is of high cover it indicates over-grazing, disturbed or infertile soils, compaction and low amounts of litter.

***Bromus hordeaceus-Aira caryophyllea/Erodium* sp.**
Soft Chess-Silver Hairgrass/Storksbill
BRHO2-AICA/ERODI Association, EcoCode: GASCFX02
Wildlife Habitat Relationships Type: Annual Grassland

SUMMARY TABLE
(Sample size: 9)

Species Richness: 20.8
Shannon Index: 2.2

Environment:
Distance to the Ocean: 29-35 mi.;
Elevation: 2450-4210 ft.;
Aspect: Southwest, Southeast,
outliers west, northeast;
Slope: 10-40%;
Slope Position: Upper 1/3;
Micro-relief:
Horizontal: convex, linear, undulating;
Vertical: linear;
Bare ground: 5-20%;
Surface Rock: 2-17%;
Litter Cover: 0-2%

Ecological Status (Mean % Cover):

	Grasses	Forbs
Ann. Native	0.0	20.9
Ann. Exotic	73.8	8.4
Perenn. Native	1.6	11.4
Perenn. Exotic	0.6	10.6

Seral Status:	R5 Grasses	R5 1-5 Year	R5 Forbs
Early	74.0	36.7	37.4
Mid	0.4	2.4	8.7
Late	1.3	33.9	3.1

Soils:
Pit Depth: 40+ in.;
AWC: 1.6-3.5 in.;
Parent Material: sandstone;
A Horizon:
Coarse Fragments: 8-25%;
Textures: CL, L, GL, GFSL, GSL;
Clay content: 12-27%;
Thickness: 4-14 in.;
Surface pH: 6.2-6.7;
Depth to Argillic Horizon: 11-17 inches

		% COVER RANGE	MEAN	CON
Tree Overstory Layer				
None				
Tree Understory Layer				
None				
Shrubs				
None				
Forbs				
ERODI	*Erodium* sp.	0-20	5	89
HYRA3	*Hypochaeris radicata*	0-20	5	78
LOTUS	*Lotus* sp.	0-10	3	78
CRIN8	*Cryptantha intermedia*	0-5	2	78
DICAC5	*Dichelostemma capitatum* ssp. *c.*	0-2	1	78
LINAN	*Linanthus* sp.	0-3	1	78
CLARK	Clarkia sp.	0-15	10	67
LACA7	*Lasthenia californica*	0-10	4	67
CEGL2	*Cerastium glomeratum*	0-5	2	56
DAPU3	*Daucus pusillus*	0-25	10	44
TAOF	*Taraxacum officinale*	0-10	3	44
GISP3	*Githopsis specularioides*	0-1	1	44
LODI	*Lomatium dissectum*	0-5	4	33
SABI3	*Sanicula bipinnatifida*	0-5	2	33
LUPIN	*Lupinus* sp.	0-1	1	33
RUAC	*Rumex acetosella*	0-25	13	22
HEMI9	*Hesperolinum micranthum*	0-15	9	22
SIMA2	*Sidalcea malvaeflora*	0-10	5	22
ERNU3	*Eriogonum nudum*	0-5	4	22
Noxious Weeds				
CESO3	*Centaurea solstitialis*	0-20	6	44
Total Forb Cover		20-70	51	100
Graminoids				
BRHO2	*Bromus hordeaceus*	1-50	27	100
AICA	*Aira caryophyllea*	1-50	24	100
AVBA	*Avena barbata*	0-10	5	67
CYEC	*Cynosurus echinatus*	0-5	3	56
BRDI3	*Bromus diandrus*	0-10	6	33
VUBR	*Vulpia bromoides*	0-5	3	33
Noxious Weeds				
BRTE	*Bromus tectorum*	0-50	19	67
BRMAR	*Bromus madritensis* ssp. *rubens*	0-10	5	44
Total Graminoid Cover		30-85	76	100

PHYSICAL AND BIOLOGICAL ENVIRONMENT

Distribution/Setting:

The plant association was found in the Central Franciscan Subsection in the northern portion of the Northern California Coast Ranges Section of the National Hierarchy. Sites were located on the Mad River Ranger District of the Six Rivers National Forest. Mean distance to the Pacific Ocean was 30.4 miles and ranged from 28.8 to 35.3 miles.

Elevation averaged 3153 feet, towards the middle of the *Bromus hordeaceus* alliance, and ranged from 2450 to 4210 feet. Mean annual precipitation averaged 61 inches and fell towards the high end of the series. Slopes were moderately steep, averaging 30% and ranging from 10 to 40%. Aspects were mainly southwest and southeast and occasionally northeast and west. Mean annual radiation index was a hot .524.

Sites were generally located in upper 1/3 slope positions with convex, linear and undulating horizontal micro-relief and linear vertical micro-relief. These factors usually lead toward drier site conditions.

Soil Summary:

Soils in this type were thermic (100%) and deep (100%). Soil drainage was well drained. They formed in colluvium from sandstone sedimentary rocks. The litter layer was mainly absent in this community. Bare ground averaged 12%, second highest in the Bromus hordeaceus alliance, and ranged from (5-20%). Surface rock and gravel averaged 10% cover and ranged from 2-17%. The surface horizon averaged 10 inches thick and ranged from 4-14 inches thick. It had loam, clay loam, gravelly loam, gravelly fine sandy loam and gravelly sandy loam textures. Surface colors were 2.5Y 4/2 (dark grayish brown), 2.5Y 5/2 (grayish brown) and 2.5YR 6/2 (light brownish gray). Coarse fragment content averaged 16% and ranged from 8-25%. Clay content averaged 19% and ranged from 12-27%. Soil pH averaged 6.5 (slightly acid) and ranged from 6.2-6.7.

The subsoils had gravelly clay loam, clay loam and gravelly sandy clay loam textures. Subsoil colors were 2.5Y 4/2 (dark grayish brown) and 2.5Y 4/1 (dark gray). Subsoil coarse fragment content averaged 34% and ranged from 7% to 75%. Subsurface clay content averaged 31% and ranged from 12% to 38%. Subsurface pH averaged 6.7, neutral and ranged from 6.6 to 6.9. The soils were 50% skeletal. Soil AWC averaged 2.1 inches, lowest in the *Bromus hordeaceus* alliance and ranged from 1.6 inches to 3.5 inches. The soils were classified into the subgroups Typic Argixeroll, Typic Xerorthent and Typic Haploxeralf.

Argillic horizons were the primary diagnostic horizon in 67% of the plots. This horizon usually leads to drier conditions that influence grass cover by restriction of rooting depth. In this case, depth to the argillic horizon averaged 12 inches, lowest in the *Bromus hordeaceus* alliance. This type was found primarily on dry upper 1/3 slopes with convex and linear micro-relief, high bare ground and high surface rock and gravel cover. These factors together with the argillic horizons contribute to moderate total vegetation cover.

Vegetation Summary:

Total vegetation cover averaged 79% and consisted of grasses (76%) and forbs (51%). Both the tree layer and shrub layer were absent. The forb layer was dominated by filaree (*Erodium* spp., 5%), smooth cat's-ear (*Hypochaeris radicata,* 5%) and *Lotus* species (3%), and often contained low (1%) cover of bluedicks (*Dichelostemma capitatum* ssp. *capitatum*) and *Linanthus* species. Soft chess (*Bromus hordeaceus*, 27%) was codominant in the grass layer with silver hairgrass (*Aira caryophyllea*, 24%). Slender oat (*Avena barbata*, 6%) was a common low cover associate.

Species Richness:
Mean species richness was 20.8 species/plot, second lowest in the *Bromus hordeaceus* alliance. Shannon diversity index was 2.2, second lowest in the series. Native grass species diversity was 0.7 species/plot. It appears to have been affected by the aggressive nature of non-native grasses and the moderate site productivity capabilities present here. For example, 55% of the 9 plots sampled in this type had no native grasses while an additional 22% had only one native grass species present. Conversely, non-native grasses dominated the grass layer with an average of 5.9 species/plot. In contrast, forb species diversity was reversed with an average of 9.8 native species/plot and 4.2 non-native species/plot.

Ecological Status:
This type had the highest cover of grasses (76%) in the *Bromus hordeaceus* series. Grass cover was split between annual species (74%) and perennial species (2%). All of the annual grass cover was made up of non-native species (74%), while perennial grass cover was primarily native species (2%). None of the plots had > 10% cover of perennial native grass species.

The grass layer seral status points toward the dominance of cover in early seral species (74%). This was the highest mean early seral grass cover in the *Bromus hordeaceus* alliance. It had very low cover in mid-seral species (< 1%) and late seral species (1%). None of these plots had > 10% cover of mid seral species and only one exceeded 10% cover of late seral species.

In the short-term (1-5 years) the overall species composition is improving. High disturbance species cover is till high (37%), but low disturbance cover is much improved (34%). Medium disturbance speciescover is still low (2%). Eighty-nine percent of the plots had > 20% cover of low disturbance species and forty-four percent had > 40% cover of low disturbance species. This indicates that increased management efforts here could lead to an improvement in short-term and eventually long-term ecological status.

Mean forb cover was high (51%) and was split between annual species (29%) and perennial species (22%). This differed substantially from the grass layer with 21% of the annual cover and 11% of the perennial cover being made up of native species. Seventy-eight percent of the plots in this type had > 20% cover of native forbs and forty-four percent had > 40% cover of native forbs.

The long-term seral status of forb species also shows an unbalanced composition similar to that of the grass layer. It included mean forb cover of 37% early, 9% mid and 3% late seral species. Seventy-seven percent of the plots had > 20% cover of early seral forb species, while none of the plots had > 20% cover of mid or late seral forb species.

Management Emphasis Rating:
The management emphasis rating for this type was generally high. This was due to the high bare ground, high surface gravel and rock, high cover of noxious and invasive weeds and cover of high disturbance species. Further analysis at the plot level could identify opportunities for treatment of localized weed infestations to check their spread.

Site Potential:
This type contained several native perennial grass species of low constancy and cover. They included *Elymus glaucus, Elymus elymoides, Juncus patens* and *Achnatherum lemmonii*. These species can be considered as remnants of the past community and should be considered as long-term restoration objectives.

Closely Related Types:
This type is most closely related to the *Bromus hordeaceus-Aira caryophyllea/ Dichelostemma capitatum* type. It is found on wetter, inland sites, at lower elevations, in lower slope micro-positions with low surface gravel and rock.

Noxious Weeds
High cover of the CalEPPC List A1 noxious weed, cheatgrass (*Bromus tectorum*, 19%) was found on 67% of the plots in this type and moderate cover of yellow star-thistle (*Centaurea solstitialis*, 6%) was found on 44% of the plots. Moderate cover of red brome (*Bromus madritensis*, 5%) was also found in 44% of the plots in this plant association.

MANAGEMENT IMPLICATIONS:
Thirty-three percent of the plots in this type had $\geq$ 20% bare ground and an additional 20% had $\geq$20% rock and gravel. These areas will require recovery time in order to prevent exceeding Region 5 soil erosion standards. *Aira caryophyllea, Bromus tectorum* and *Centaurea solstitialis* are all indicators of a degraded site. The lack of any litter accumulation indicates that grazing use will need to be reduced substantially to increase plant and litter cover to protect against ongoing surface soil erosion. With the very high bare ground conditions, further invasion of *Centaurea solstitialis* and *Bromus tectorum* is likely under continued grazing use. The presence of several species of *Clarkia* also support the conclusion that the site is not fully stocked with herbaceous species such that soil water is available for continued weed invasion.

In order to determine whether current livestock grazing is substantially removing plant material, plots in exclosure cages could be monitored over one grazing season and compared with paired grazed plots. Clippings of plant material inside and outside exclosures would determine site production, potential and utilization rates by livestock. The reason for doing such baseline monitoring in this type would be to determine whether the sparse vegetation cover is due to current use vs. low inherent productivity due to past abusive grazing and/or extreme erosion events, or their combination.

Until the reason for the sparse vegetative cover is determined, further efforts to increase abundance of native grasses are premature. *Elymus elymoides* and *Achnatherum lemmonii* would be strong candidate native perennial grasses to consider for site restoration. Desirable non-native grasses including *Avena barbata* and *Bromus hordeaceus*, should be managed for in future grazing programs as a step toward developing litter layers conducive to perennial grass establishment.

Thirty percent of the plots in this type had soils rated as having a high sensitivity to compaction.

It is recommended that small infestations of yellow star-thistle be completely eradicated, with monitoring in subsequent years to track re-infestation from the seed bank. Large infestations of cheatgrass are best addressed by subjecting the population to a combination of treatments to keep it under constant stress, each treatment reinforcing the others. These include: 1) prescribed burning in summer/ fall to destroy the seed crop; 2) carefully timed grazing; 3) reseeding with native perennials to provide competition; and 4) herbicides. There are no known biological controls.

The aim is to eliminate new seed production and deplete the existing seedbank, and then develop management practices that deter re-infestation. Any eradication program should be expected to be long term, as noxious weeds have a large seedbank that will allow the population to re-establish itself for several years.

Plant Association: ***Bromus hordeaceus-Aira caryophyllea/ Dichelostemma capitatum* var. *capitatum***
Soft Chess-Silver Hairgrass/Bluedicks
EDP Code: **BRHO2-AICA/DICAC5**
EcoCode: **GASCFX03**

Indicator Species:

***Bromus hordeaceus* (Soft Chess):** This non-native, annual grass species was the most common grass species found in the Northern Province annual grasslands and should be considered naturalized. It was found on dry, warm, south and east facing, mid-elevation sites throughout the southern portion of the Northern Province.

Bromus hordeaceus-Aira caryophyllea/Dichelostemma capitatum var. capitatum

Soft Chess-Silver Hairgrass/Bluedicks

BRHO2-AICA/DICAC5 Association, EcoCode: GASCFX03

Wildlife Habitat Relationships Type: Annual Grassland

SUMMARY TABLE

(Sample size: 41)

Species Richness: 20.2

Shannon Index: 2.3

Environment:

Distance to Ocean: 32-37 miles;
Elevation: 1900-3900 ft.;
Aspect: Southwest, Southeast.;
Slope: 15-60%;
Slope Position: Middle, Upper, Lower 1/3;
Micro-relief:
  Horizontal: linear, convex;
  Vertical: linear;
Surface Rock: 1-30%;
Bare ground: 2-40%;
Litter Cover: 0-15%, outlier 30%.

Ecological Status (Mean % Cover):

	Grasses	Forbs
Ann. Native	0.6	35.8
Ann. Exotic	50.7	6.7
Perenn. Native	0.5	7.7
Perenn. Exotic	0.0	1.2

Seral Status:	R5 Grasses	1-5 Year	R5 Forbs
Early	51.3	16.7	38.2
Mid	0.2	3.2	15.9
Late	0.3	26.7	2.7

Soils:

Pit Depth: 4-4+ in.;
AWC: 1.6-3.3 in.;
Parent Material: Sandstone;
A Horizon:
  Coarse Fragments: 10-35%;
  Textures: L, GL, GSL, SICL;
  Clay content: 16-28%;
  Thickness: 3-24 in.;
Surface pH: 5.5-7.0;
Depth to Argillic Horizon: 13 inches

		% COVER RANGE	MEAN	CON
Tree Overstory Layer				
QUGA4	*Quercus garryana*	0-2	2	2
Tree Understory Layer				
QUGA4	*Quercus garryana*	0-2	1	2
Shrubs				
ARPA6	*Arctostaphylos patula*	0-2	2	2
Forbs				
DICAC5	*Dichelostemma capitatum* spp. *c.*	0-5	1	88
TRIFO	*Trifolium* sp.	0-45	14	78
LOTUS	*Lotus* sp.	0-25	9	67
ERBO	*Erodium botrys*	0-15	4	54
LIBI	*Linanthus bicolor*	0-15	4	49
DAPU3	*Daucus pusillus*	0-10	3	46
HECOL	*Hemizonia congesta* var. *luzulaefolia*	0-10	3	46
CLGR	*Clarkia gracilis*	0-15	6	44
CLPUQ	*Clarkia purpurea* ssp. *quadrivulnera*	0-15	6	41
CEGL2	*Cerastium glomeratum*	0-4	2	41
SIDI	*Sidalcea diploscypha*	0-6	2	41
GALIU	*Galium* sp.	0-5	2	39
MICAC2	*Micropus californicus* var. *c.*	0-50	10	37
LODI	*Lomatium dissectum*	0-5	2	37
ERCI	*Erodium cicutarium*	0-10	5	32
SABI3	*Sanicula bipinnatifida*	0-5	2	29
MAEL	*Madia elegans*	0-15	6	27
GEDI	*Geranium dissectum*	0-10	4	22
HYRA3	*Hypochoeris radicata*	0-4	2	22
LUNA	*Lupinus nanus*	0-15	4	20
Noxious Weeds				
HYPE	*Hypericum perforatum*	0-1	1	7
Total Forb Cover		5-75	51	100
Graminoids				
BRHO2	*Bromus hordeaceus*	1-65	19	100
AICA	*Aira caryophyllea*	0-40	7	93
CYEC	*Cynosurus echinatus*	0-25	7	68
AVBA	*Avena barbata*	0-15	6	68
BRDI3	*Bromus diandrus*	0-10	5	44
BRMI2	*Briza minor*	0-8	3	37
Noxious Weeds				
BRTE	*Bromus tectorum*	0-25	10	80
BRMAR	*Bromus madritensis* ssp. *rubens*	0-20	7	39
Total Graminoid Cover		20-80	52	100

PHYSICAL AND BIOLOGICAL ENVIRONMENT

Distribution/Setting:

This plant association was found in the Eastern Franciscan and Central Franciscan subsections in the north-central portion of the Northern California Coast Ranges Section of the National Hierarchy. Sites were located on the Mad River Ranger District of the Six Rivers National Forest. Mean distance to the Pacific Ocean was 33.3 miles and ranged from 30.1-42.0 miles.

Elevation averaged 2695 feet, towards the low end of the *Bromus hordeaceus* alliance. It had a range of 1900 to 3900 feet. Mean annual precipitation averaged 65 inches and was the highest in the series. Slopes were steep, averaging 36% and ranging from 15-60%. Aspects were southwest and southeast with a hot mean annual radiation index of .551, highest in the series.

Sites were located primarily in the middle and upper 1/3 slope positions and rarely on lower 1/3 slopes. Horizontal micro-relief was mainly linear and convex; vertical micro-relief was linear.

Soil Summary:

Soils in this type were thermic (100%), deep (57%), moderately deep (30%) and shallow (13%). Soil drainage was well-drained and moderately well-drained. Soils formed in colluvium and residuum from sandstone sedimentary rocks. The litter layer had an average thickness of 0.2 inches at 10% cover. Bare ground averaged 12%, second highest in the *Bromus hordeaceus* alliance, and ranged from 2-40%. Surface rock and gravel averaged 9% cover and ranged from 1-30%. The surface horizon averaged 10 inches thick and ranged from 3-24 inches thick. It had loam, gravelly loam, gravelly sandy loam and silty clay loam textures. Surface colors were 2.5Y 3/2 (very dark grayish brown) and 10YR 3/3 (dark brown). Coarse fragment content averaged 19% and ranged from 10-35%. Clay content averaged 22% and ranged from 16-28%. Soil pH averaged 6.2 (slightly acid) and ranged from 5.5-7.0.

The subsoils had very gravelly clay, gravelly clay loam and clay loam textures. Subsoil colors were 2.5Y 3/2 (very dark grayish brown), 2.5Y 4/2 (dark grayish brown) and 10YR 4/3 (dark brown). Subsoil coarse fragment content averaged 26% and ranged from 8% to 45%. Subsurface clay content averaged 35% and ranged from 10% to 50%. Subsurface pH averaged 6.4, slightly acid and ranged from 5.5 to 7.8. The soils were 8% skeletal. Soil AWC averaged 2.5 inches and ranged from 1.6 inches to 3.3 inches. They were classified into the subgroups Typic Xerorthents, Mollic Haploxeralfs and Typic Argixerolls.

Argillic horizons were the primary diagnostic horizon in 74% of the plots. Average depth to the argillic horizon was 13 inches, second lowest in the *Bromus hordeaceus* alliance. This shallow horizon usually leads to drier conditions that influence grass cover by restriction of rooting depth. Other factors such as middle 1/3 slopes with linear and convex micro-relief, moderate slopes, high bare ground, moderate surface rock and gravel cover also contribute to the productive capabilities of this type. These factors together with the argillic horizons contribute to moderate total vegetation cover and the lowest grass cover in the series.

Vegetation Summary:
Total vegetation cover was 77% and consisted of forbs (51%) and grasses (52%). Both the tree layer and shrub layer were absent. The forb layer was highly diverse, with over 90 species represented among plots. Clovers (*Trifolium* spp., 14%), including *T. albopurpureum, T. bifidum, T. fucatum, T. microdon, T. wildenovii*, and *T. variegatum*, were predominant among plots in association with low cover of bluedicks (*Dichelostemma capitatum* ssp. *capitatum*, 1%). The grass layer was dominated by soft chess (*Bromus hordeaceus*, 20%) and included silver hairgrass (*Aira caryophyllea*, 7%) and the noxious weed, cheatgrass (*Bromus tectorum*, 10%) among its numerous members.

Species Richness:
Mean species richness was 20.2 species/plot, lowest in the *Bromus hordeaceus* alliance. Shannon diversity index was 2.3. Native grass species diversity was 0.4 species/plot. It appears to have been affected by the aggressive nature of non-native grasses. For example, 73% of the 41 plots sampled in this type had no native grasses while an additional 17% had only one native grass species present. Conversely, non-native grasses dominated the grass layer with an average of 5.8 species/plot. In contrast, forb species diversity is reversed with an average of 11.0 native species/plot and 2.3 non-native species/plot.

Ecological Status:
This type had the second lowest cover of grasses (51%) in the *Bromus hordeaceus* alliance. Grass cover was split between annual species (51%) and perennial species (1%). Almost all of the annual grass cover was made up of non-native species (51%), while perennial grass cover was primarily native species (1%). None of the 41 plots in this type had > 10% cover of perennial native grass species.

The long-term grass layer seral status points toward an unbalanced system dominated by cover of early seral grass species (51%). This was the second lowest mean early seral cover in the *Bromus hordeaceus* series. It had very low cover in mid and late seral grass species (< 1%). None of these plots had > 10% cover of mid seral or late seral species.

In the short-term (1-5 years) the overall species composition is somewhat better with moderate mean cover of high disturbance species (17%), low cover of medium disturbance species (3%) and moderate llow disturbance species cover (27%). This is likely related to reduced disturbance by cattle grazing as stocking rates have declined. Historical impacts of cattle grazing appear to have been higher as indicated by < 1% cover of late seral species This is supported by the fact that cover of high disturbace species (17%) is much below the presence of early seral plants (51%), indicating that increased management efforts here could lead to an improvement in short-term and eventually long-term ecological status.

Forb cover was high (52%) and was split between annual species (43%) and perennial species (9%). This differed substantially from the grass layer with 36% of the annual cover and 8% of the perennial cover being made up of native species. Eighty-five percent of the plots in this type had > 20% cover of native forbs and fifty-nine percent had > 40% cover of native forbs.

The long-term seral status of forb species also shows an unbalanced composition similar to that of the grass layer. It included mean forb cover of 38% early, 16%

mid and 3% late seral species. Seventy-eight percent of the plots had > 20% cover of early seral species, while thirty-two percent of the mid seral plots had > 20% cover. None of the plots had > 20 % cover of late seral species.

Management Emphasis Rating:
The management emphasis rating for this type was generally high and low. This was due to a combination of factors including high bare ground, high surface gravel and rock, high noxious and invasive weed cover and cover of high disturbance species. Twenty-four percent of the plots were rated as low need for management treatment. These plots could serve as a model for management in this type.

Site Potential:
This type contains a host of native perennial and annual grass species of low constancy and cover. These include *Bromus carinatus*, *Danthonia californica*, *Elymus glaucus*, *Festuca californica*, *Juncus* spp., *Luzula comosa*, *Poa secunda*, *Achnatherum lemmonii* and *Vulpia microstachys*. These species can be considered as remnants of the past community and should be considered as long-term restoration objectives.

Closely Related Types:
This type is most closely related to the *Bromus hordeaceus-Aira caryophyllea/ Erodium* sp. type. It is found on slightly drier, more coastal sites, at higher elevations, in upper 1/3 slope micro-positions with moderate surface gravel and rock.

Noxious Weeds:
This plant association had high cover of the CalEPPC List A1 noxious weed, cheatgrass (*Bromus tectorum*, 10%) in 79% of the plots, as well as moderate cover of red brome (*Bromus madritensis* ssp. *rubens*, 7%) and low cover of St. John's wort (*Hypericum perforatum*, 1%) in 7% of the plots.

MANAGEMENT IMPLICATIONS:

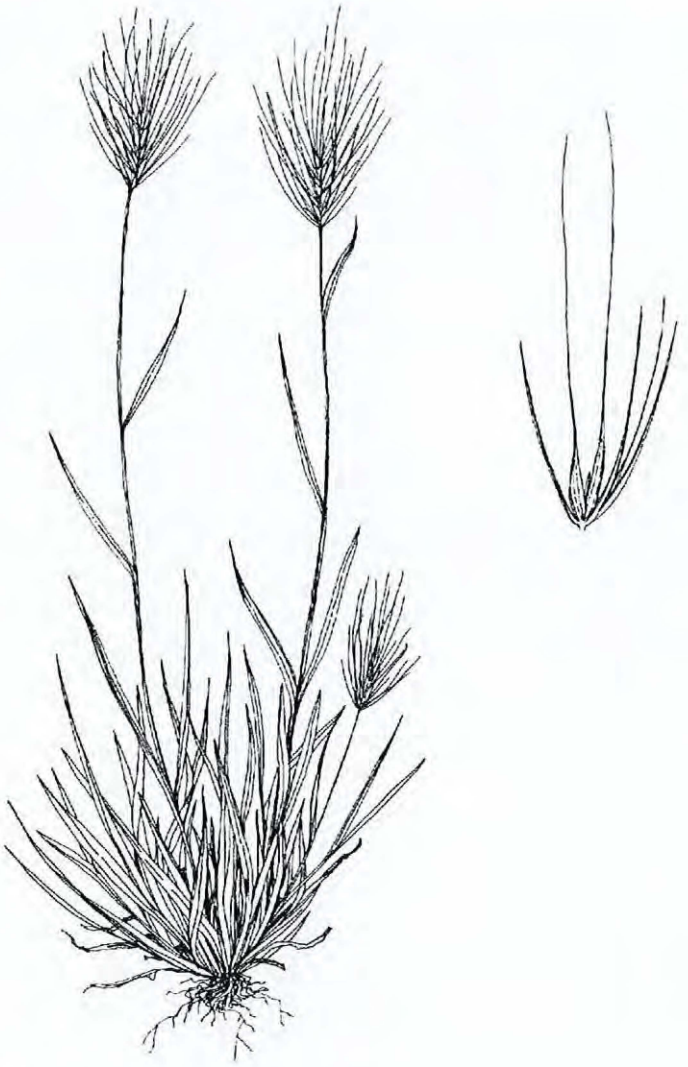
Twenty-two percent of the plots in this type had $\geq$ 20% bare ground, an additional fourteen percent had > 20 surface rock and gravel. These areas will require recovery time in order to prevent exceeding Region 5 soil erosion standards.

Seventy percent of the plots in this type had soils rated as having a high to moderate sensitivity to compaction.

Forty-four percent of the plots had > 10 percent noxious and invasive weed cover. Large infestations of cheatgrass are best addressed by subjecting the population to a combination of treatments to keep it under constant stress, each treatment reinforcing the others. These include: 1) prescribed burning in summer/fall to destroy the seed crop; 2) carefully timed grazing; 3) reseeding with native perennials to provide competition; and 4) herbicides. There are no known biological controls.

Small infestations of red brome can be eliminated by manual removal. Leaving the pulled plants in place as a surface mulch would shade the soil, impeding further germination from the seed bank. Late fall burning in conjunction with sowing of perennial grasses is suggested for larger infestations. Red brome is shallow-rooted and shade-intolerant; therefore grazing and burning without sowing and/or mulching may increase its abundance.

Plant Association: ***Bromus hordeaceus-Taeniatherum caput-medusae/Erodium botrys***
Soft Chess-Medusahead/Long-beaked Storksbill
EDP Code: **BRHO2-TACA8/ERBO**
EcoCode: **GASCFX04**



Indicator Species:

Taeniatherum caput-medusae **(Medusahead):** This non-native, annual grass is considered a noxious weed. It affects natural succession through accumulation of litter that is high in silica, which retards decomposition. The resultant litter mat, 5-12.5 cm thick in established populations, can persist for over two years, inhibiting germination of most other species. Medusahead is found in annual grasslands on clay soils.

Bromus hordeaceus-Taeniatherum caput-medusae/Erodium botrys
Soft Chess-Medusahead/Long-beaked Storksbill
BRHO2-TACA8/ERBO Association, EcoCode: GASCFX04
Wildlife Habitat Relationships Type: Annual Grassland

SUMMARY TABLE
(Sample size: 18)

Species Richness: 24.2
Shannon Index: 2.2

Environment:
Distance to Ocean: 29-47 miles;
Elevation: 1920-4220 ft.;
Aspect: Southeast, Southwest, Northeast;
Slope: 8-37%;
Slope Position: Middle 1/3, Upper 1/3;
Micro-relief:
  Horizontal: linear, convex;
  Vertical: linear, undulating;
Bare ground: 1-30%;
Surface Rock: 0-15%;
Litter Cover: 5-25%, outlier 60%.

Ecological Status (Mean % Cover):

	Grasses	Forbs
Ann. Native	0.2	19.9
Ann. Exotic	65.3	9.5
Perenn. Native	12.1	6.3
Perenn. Exotic	0.1	0.5

Seral Status:	R5 Grasses	1-5 Year	R5 Forbs
Early	64.2	9.1	223.1
Mid	2.3	0.7	9.4
Late	7.9	27.7	1.7

Soils:
Pit Depth: 33-60 in.;
AWC: 2.5-3.0 in.;
Parent Material: Sandstone;
A Horizon:
  Coarse Fragments: 2-27%;
  Textures: L, GCL;
  Clay content: 17-24%;
  Thickness: 3-14 in.;
Surface pH: 6.5-7.0;
Depth to Argillic Horizon: 31 inches

		% COVER RANGE	MEAN	CON
Tree Overstory Layer				
None				
Tree Understory Layer				
None				
Shrubs				
None				
Forbs				
TRIFO	*Trifolium* sp.	0-17	4	78
ERBO	*Erodium botrys*	0-5	2	78
LUPIN	*Lupinus* sp.	0-3	1	67
DICAC5	*Dichelostemma capitatum* ssp. *c.*	0-2	1	63
TOAR	*Torilis arvensis*	0-15	5	56
CLARK	*Clarkia* sp.	0-3	1	56
LIBI	*Linanthus bicolor*	0-5	1	56
LOTUS	*Lotus* sp.	0-5	1	56
PLAGI	*Plagiobothrys* sp.	0-2	1	56
LOHU	*Lotus humistratus*	0-15	3	50
MADIA	*Madia* sp.	0-30	8	50
EPBR3	*Epilobium brachycarpum*	0-1	1	50
CEGL2	*Cerastium glomeratum*	0-15	3	44
AGHE2	*Agoseris heterophylla*	0-3	1	44
ATPU	*Athysanus pusillus*	0-1	1	44
ACMO2	*Achyrachaena mollis*	0-5	3	28
Noxious Weeds				
CESO3	*Centaurea solstitialis*	0-55	11	28
HYPE	*Hypericum perforatum*	0-1	1	6
Total Forb Cover		2-80	36	100
Graminoids				
BRHO2	*Bromus hordeaceus*	1-60	19	100
AICA	*Aira caryophyllea*	0-40	14	67
CYEC	*Cynosurus echinatus*	0-35	19	39
BRDI3	*Bromus diandrus*	0-30	6	39
AVFA	*Avena fatua*	0-40	11	33
BRMI2	*Briza minor*	0-2	1	28
Noxious Weeds				
TACA8	*Taeniatherum caput-medusae*	2-85	30	100
BRMAR	*Bromus madritensis* ssp. *rubens*	0-5	2	28
BRTE	*Bromus tectorum*	0-15	8	11
Total Graminoid Cover		15-95	78	100

PHYSICAL AND BIOLOGICAL ENVIRONMENT

Distribution/Setting:

This plant association was found in the Eastern Franciscan, Central Franciscan and Clear Lake Hills and Valleys subsections of the Northern California Coast Ranges Section of the National Hierarchy. Sites were located on the Upper Lake, Covelo and Grindstone (Corning) Ranger Districts of the Mendocino National Forest and on the Mad River Ranger District of the Six Rivers National Forest. Mean distance to the Pacific Ocean was 42.4 miles and ranged from 29.1-46.9 miles.

Elevation averaged 3083 feet, towards the middle of the *Bromus hordeaceus* alliance. It had a range of 1920 to 4220 feet. Mean annual precipitation averaged 50 inches and fell toward the low end of the series. Slopes were moderately steep, averaging 26% and ranging from 8-37%. Aspects were southeast and southwest and occasionally northeast. Mean annual radiation index was a warm .500.

Sites were located primarily in the upper and middle 1/3 slope positions with linear/ convex horizontal micro-relief and linear/undulating vertical micro-relief. These factors lead water to flow though and away from this type, contributing to the drier conditions found here.

Soil Summary:

Soils in this type were found in the mesic (83%) and thermic (17%) temperature regimes. Soil depth was shallow (33%), moderately deep (17%) and deep (50%). Soil drainage was somewhat excessively drained and moderately well drained. Soils formed in residuum from the sedimentary rocks, sandstone and argillite. The litter layer had an average thickness of 0.6 inches at 25% cover. Bare ground averaged 10% and ranged from (1-30%). Surface rock and gravel averaged 10% cover and ranged from 0-15%. The surface horizon averaged 9 inches thick and ranged from 3-14 inches thick. It had loam and gravelly clay loam textures. Surface colors were 10YR 3/1 (very dark gray), 10YR 3/3 (dark brown), 10YR 4/2 (dark grayish brown) and 10YR 3/2 (very dark grayish brown). Coarse fragment content averaged 18% and ranged from 2-27%. Clay content averaged 20% and ranged from 17-24%. Soil pH averaged 6.7 (neutral) and ranged from 6.5-7.0.

The subsoils had clay loam, clay and gravelly clay textures. Subsoil colors were 2.5YR 4/2 (weak red), 7.5YR 6/1 (gray) and 10YR 4/4 (dark yellowish brown). Subsoil coarse fragment content averaged 22% and ranged from 10% to 30%. Subsurface clay content averaged 35% and ranged from 28% to 45%. Subsurface pH averaged 6.8, neutral and ranged from 6.5 to 7.0. The soils were 100% non-skeletal. Soil AWC averaged 2.7 inches, second highest in the *Bromus hordeaceus* alliance, and ranged from 2.5 inches to 3.0 inches. The soils were classified into the subgroups Typic Xerorthents, Dystric Xerochrepts and Ultic Argixerolls.

Argillic horizons were found in only 33% of these plots, and were located at a mean depth of 31 inches. This type was found primarily in middle 1/3 slopes with linear and convex micro-relief, moderate slopes, moderate bare ground, surface rock and gravel cover. These factors, together with the lack of an effective argillic horizon, contribute to moderate total vegetation cover and high grass cover.

Vegetation Summary:

Total vegetation cover was 77% and was dominated by grasses (63%). Both the tree layer and shrub layer were absent. The 31% cover of the forb layer was very diverse, consisting of over 95 species among plots. Long-beaked storksbill (*Erodium botrys*, 2%) was the most common forb. The grass layer was dominated by the noxious weed,

medusahead (*Taeniatherum caput-medusae*, 30%) and soft chess (*Bromus hordeaceus*, 19%), and often included silver hairgrass (*Aira caryophyllea*, 14%). Cover of medusahead was 45-85% on 28% of the plots in this plant community, on both forests. Native grasses accounted for less than 3% of the total grass cover in this type.

Species Richness:
Mean species richness was 25.1 species/plot, highest in the *Bromus hordeaceus* alliance. Shannon diversity index was 2.2. Native grass species diversity was 0.8 species/plot. It appears to have been affected by the aggressive nature of non-native grasses. For example, 50% of the 18 plots sampled in this type had no native grasses while an additional 22% had only one native grass species present. Conversely, non-native grasses dominated the grass layer with an average of 5.4 species/plot. In contrast, forb species diversity was reversed with an average of 13.8 native species/plot and 4.3 non-native species/plot.

Ecological Status:
The long-term grass layer seral status points toward an unbalanced system dominated by cover of early seral grass species (67%). This was the second highest mean early seral cover in the *Bromus hordeaceus* series. It had low cover in mid seral species (2%) and late seral grass species (7%). Only one of these plots had > 10% cover of mid seral species.

In the short-term (1-5 years) the overall species composition is moderately well balanced. It had low cover of high disturbance grass species (11%), low cover of miedium disturbance species (1%) and moderate cover of low disturbance related tall annual grasses (28%). This is likely related to reduced disturbance by cattle grazing as stocking rates have declined. Historical impacts of cattle grazing appear to have been higher as indicated by only 7% cover of late seral species. This is further supported by the fact that cover of high disturbace species (11%) is much below the presence of early seral plants (67%). This indicates that increased management efforts here could lead to an improvement in short-term and eventually long-term ecological status.

Forb cover was moderate (37%) and was split between annual species (30%) and perennial species (7%). This differed substantially from the grass layer with 20% of the annual cover and 7% of the perennial cover being made up of native species. Sixty-nine percent of the plots in this type had > 20% cover of native forbs and 25% had > 40% cover of native forbs.

The long-term seral status of forb species also shows an unbalanced composition similar to that of the grass layer. It included mean forb cover of 24% early, 9% mid and 2% late seral species. Fifty-six percent of the plots had > 20% cover of early seral species, while none of the mid or late seral plots had > 20% cover.

Management Emphasis Rating:
The management emphasis rating for this type was generally high. This was primarily due to the high cover of noxious and invasive weed species and the infrequent high bare ground and high surface gravel and rock cover.

Site Potential:
This type contains a host of native perennial and annual grass species of low constancy and cover. These include *Bromus carinatus, Danthonia californica, Elymus glaucus, Juncus bufonius, Juncus nevadensis, Luzula comosa, Poa secunda* and *Nasella pulchra*. These species can be considered as remnants of the past community and should be considered as long-term restoration objectives.

Closely Related Types:
This type is closely related to the *Bromus hordeaceus/Erodium botrys* type. They differ in the more inland position, higher elevation, warmer aspects and higher forb cover of the latter.

Noxious Weeds:
This plant association contained high cover of the Cal-EPPC List A1 noxious weeds, medusahead (*Taeniatherum caput-medusae*, 30% on 100% of the plots), and cheatgrass (*Bromus tectorum*, 8%) and yellow star-thistle (*Centaurea solstitialis*, 28%) in 11% of the plots. Low cover of red brome (*Bromus madritensis* ssp. *rubens*, 2%) was noted in 27% of the Mendocino plots, and low cover of St. John's wort (*Hypericum perforatum*, 1%) was found in 34% of the Mad River plots.

MANAGEMENT IMPLICATIONS:

Twenty-four percent of the plots in this type had $\geq$ 20% bare ground. These areas will require recovery time in order to prevent exceeding Region 5 soil erosion standards. Twenty percent of the plots in this type had soils rated as having a moderate sensitivity to compaction.

Seventy-six percent of the plots in this type had > 10% noxious and invasive weed cover. Recommended treatments against medusahead (*Taeniatherum caput-medusae*) infestations include: controlled burning in late spring when seeds are still immature, "flash" grazing or heavy grazing during spring before seed heads form, especially in areas previously burned, and restoration using squirrel-tail (*Elymus elymoides*). Successful eradication of large infestations of medusahead has not been demonstrated. It is imperative that small populations are controlled before they explode.

Small infestations of red brome (*Bromus madritensis* ssp, *rubens*) can be eliminated by manual removal. Leaving the pulled plants in place as a surface mulch would shade the soil, circumventing further germination from the seed bank. Late fall burning in conjunction with sowing of perennial grasses is suggested for larger infestations. Red brome is shallow-rooted and shade-intolerant; therefore grazing and burning without sowing and/or mulching may increase its abundance.

Large infestations of cheatgrass (*Bromus tectorum*) are best addressed by subjecting the population to a combination of treatments to keep it under constant stress, each treatment reinforcing the others. These include: 1) prescribed burning in summer/fall to destroy the seed crop; 2) carefully timed grazing; 3) reseeding with native perennials to provide competition; and 4) herbicides. There are no known biological controls.

To reduce large infestations of yellow star-thistle (*Centaurea solstitialis*), several controls have been utilized by land managers with varying success, the best success achieved when methods are used in combination. All are long-term endeavors that must be maintained over time. These include: 1) biological control by means of the hairy weevil and/or seedhead fly; 2) controlled grazing by cattle or sheep timed to specific stages of yellow star-thistle development; 3) mowing timed to specific stages of yellow star-thistle development and repeated at least once per season; 4) prescribed burning in late spring timed to specific stage of yellow star-thistle development; and 5) herbicides.

Bio-controls, including foliage and root-boring beetles have historically been successful in California in controlling St. John's wort (*Hypericum perforatum*).

Plant Association: ***Bromus hordeaceus-Bromus tectorum***
Soft Chess-Cheatgrass
EDP Code: **BRHO2-BRTE**
EcoCode: **GASCFX05**

Indicator Species:

***Bromus tectorum* (Cheatgrass):** Cheatgrass is a non-native annual grass and an ubiquitous component of annual grasslands and oak woodlands in Northern California. It is a winter annual that can germinate and establish root systems at lower temperatures than perennial grasses are able to do. Cheatgrass is extremely tenacious and can provide such intense competition to other newly emerging seedlings that few native plants are able to become established. An abundance of cheatgrass indicates range deterioration.

Bromus hordeaceus-Bromus tectorum
Soft Chess-Cheatgrass
BRHO2-BRTE Association, EcoCode: GASCFX05
Wildlife Habitat Relationships Type: Annual Grassland

SUMMARY TABLE
(Sample size: 9)

Species Richness: 21.0
Shannon Index: 2.3

Environment:
Distance to Ocean: 39-43 miles;
Elevation: 2520-4690 ft.;
Aspect: South;
Slope: 25-45%;
Slope Position: Upper 1/3;
Micro-relief:
  Horizontal: convex, linear;
  Vertical: linear, convex;
Surface Rock: 2-35%;
Bare ground: 5-50%;
Litter Cover: 2-10%, outlier 30%

Ecological Status (Mean % Cover):

	Grasses	Forbs
Ann. Native	0.7	10.8
Ann. Exotic	47.6	8.4
Perenn. Native	2.6	6.3
Perenn. Exotic	1.8	1.3

Seral Status:	R5 Grasses	R5 1-5 Year	R5 Forbs
Early	50.0	18.2	18.4
Mid	0.1	0.1	6.3
Late	1.9	22.0	2.0

Soils:
Pit Depth: 25-35in.;
AWC: 2.5-2.9 in.;
Parent Material: Sandstone, shale;
A Horizon:
  Coarse Fragments: 20-30%;
  Textures: CL;
  Clay content: 30-40%;
  Thickness: 4-10 in.;
Surface pH: 6.6-7.0;
Depth to Argillic Horizon: 6 inches

		% COVER RANGE	MEAN	CON
Tree Overstory Layer				
None				
Tree Understory Layer				
QUGA4	*Quercus garryana*	0-1	1	11
Shrubs				
None				
Forbs				
ERODI	*Erodium* sp.	1-30	6	100
LUBI	*Lupinus bicolor*	0-10	2	78
TRIFO	*Trifolium* spp.	0-5	2	78
CEGL2	*Cerastium glomeratum*	0-1	1	78
TOAR	*Torilis arvensis*	0-5	2	67
AGHE2	*Agoseris heterophylla*	0-1	1	67
DICAC5	*Dichelostemma capitatum* ssp. *c.*	0-1	1	67
PLNO	*Plagiobothrys nothofulvus*	0-10	3	56
DRVE2	*Draba verna*	0-2	1	56
ERSE3	*Eremocarpus setigerus*	0-4	2	44
SABI3	*Sanicula bipinnatifida*	0-5	2	44
AMME	*Amsinkia menziesii*	0-2	1	44
ATPU	*Athysanus pusillus*	0-1	1	44
LOHU2	*Lotus humistratus*	0-1	1	44
VEAR	*Veronica arvensis*	0-1	1	44
CAAT25	*Castilleja attenuata*	0-1	1	33
CRIN8	*Cryptantha intermedia*	0-1	1	33
VICIA	*Vicia* sp.	0-1	1	33
Total Forb Cover		5-50	27	100
Graminoids				
BRHO2	*Bromus hordeaceus*	3-35	17	100
AICA	*Aira caryophyllea*	0-15	8	78
CYEC	*Cynosurus echinatus*	0-40	14	44
POA	*Poa* sp.	0-10	4	44
ACLE8	*Achnatherum lemmonii*	0-10	5	33
Noxious Weeds				
BRTE	*Bromus tectorum*	5-40	12	100
TACA8	*Taeniatherum caput-medusae*	0-20	9	33
Total Graminoid Cover		30-75	53	100

PHYSICAL AND BIOLOGICAL ENVIRONMENT

Distribution/Setting:

This plant association was found in the Central Franciscan and Eastern Franciscan subsections in the northern portion of the Northern California Coast Ranges Section of the National Hierarchy. One site was located on the Covelo Ranger District of the Mendocino National Forest and the remaining sites were located on the Mad River Ranger District of the Six Rivers National Forest. Mean distance to the Pacific Ocean was 41.4 miles and ranged from 39.1-43.5 miles.

Elevation averaged 3684 feet, highest in the *Bromus hordeaceus* alliance. It had a range of 2520 to 4690 feet. Mean annual precipitation averaged 64 inches and fell toward the high end of the series. Slopes were steep, averaging 30% and ranging from 25-45%. Aspects were south with a warm mean annual radiation index of .533. Aspect effects were enhanced by slope micro-position and the lack of topographic shading.

Sites were located primarily in the upper 1/3 slope position with convex and linear horizontal micro-relief and linear/convex vertical micro-relief. These factors lead water to flow away from the type, contributing to drier site conditions.

Soil Summary:

Soils in this type were found in the thermic (100%) temperature regime. Soil depth was moderately deep (100%) with a soil drainage class of well-drained. Soils formed in residuum from shale and sandstone sedimentary rocks. The litter layer had an average thickness of 0.2 inches at 10% cover. Bare ground averaged 25%, highest in the *Bromus hordeaceus* alliance, and ranged from (5-50%). Surface rock and gravel averaged 16% cover and were also the highest in the series, ranging from 2-35% surface cover. The surface horizon averaged 6 inches thick and had clay loam texture. Surface color was 2.5Y 5/2 (grayish brown). Clay content averaged 35% and ranged from 30-40%. Coarse fragment content averaged 25% and ranged from 20% to 30%. Soil pH averaged 6.8 (neutral) and ranged from 6.6 to 7.0.

The subsoils had gravelly clay textures. Subsoil color was 2.5Y 6/2 (light brownish gray). Subsoil coarse fragment content averaged 20%. Subsurface clay content averaged 48% highest in the *Bromus hordeaceus* alliance and ranged from 40% to 55%. Subsurface pH averaged 7.0, neutral. The soils were 100% non-skeletal. Soil AWC averaged 2.8 inches and ranged from 2.5 inches to 2.9 inches. The soils were classified into the subgroup Mollic Haploxeralfs.

Argillic horizons were found in all 100% of the plots, with an average depth of 6 inches. This shallow horizon usually leads to drier conditions that influence vegetation cover by restriction of rooting depth. This type was found primarily in dry upper 1/3 slopes with convex and linear micro-relief, moderate slopes, very high bare ground, high surface rock and gravel cover. These factors, together with the argillic horizons, contribute to the lowest total vegetation cover and forb cover in the *Bromus hordeaceus* alliance.

Vegetation Summary:

Total vegetation cover was high (70%) and was dominated by grasses (53%). Aside from 1% cover of Oregon white oak (*Quercus garryana*) in the understory of one Mad River plot, both the tree layer and shrub layer were absent. Total forb cover was 26% and was dominated by filarees (*Erodium botrys,* 4%, *and E. cicutarium,* 9%), bicolored lupine (*Lupinus bicolor,* 2%), clovers (*Trifolium* spp.,

1%) and mouse-ear chickweed (*Cerastium glomeratum,* 1%). Soft chess (*Bromus hordeaceus,* 17%) and the noxious weed, cheatgrass (*Bromus tectorum,* 12%) were co-dominants in the grass layer, which often included silver hairgrass (*Aira caryophyllea,* 8%).

Species Richness:
Mean species richness was 21.0 species/plot, second lowest in the *Bromus hordeaceus* alliance. Shannon diversity index was 2.3. Native grass species diversity was 0.8 species/plot. It appears to have been affected by the aggressive nature of non-native grasses. For example, 67% of the 9 plots sampled in this type had no native grasses while an additional 11% had only one native grass species present. Conversely, non-native grasses dominated the grass layer with an average of 4.7 species/plot. In contrast, forb species diversity was reversed with an average of 12.6 native species/plot and 3.0 non-native species/plot.

Ecological Status:
This type had the lowest cover of grasses (52%) in the *Bromus hordeaceus* alliance. Grass cover was split between annual species (48%) and perennial species (4%). Almost all of the annual grass cover was made up of non-native species (48%), while perennial grass cover was primarily native species (3%). One of the nine plots in this type had > 10% cover of perennial native grass species.

The long-term seral grass status points toward an unbalanced system dominated by cover of early seral grass species (50%). This was the lowest mean early seral cover in the *Bromus hordeaceus* series. It had very low cover in mid seral species (< 1%) and low late seral grass species (2%). Only one of these plots had > 10% cover of mid seral or late seral species.

In the short-term (1-5 years) the overall species composition is somewhat better with moderate mean cover of high disturbance grass species (18%), very low cover of medium disturbance species (<1%) and moderate cover (22%) of low disturbance related tall annual grasses. This is likely related to reduced disturbance by cattle grazing as stocking rates have declined. Historical impacts of cattle grazing appear to have been higher as indicated by only 2% cover of late seral species. This is further supported by the fact that cover of high disturbace species (18%) is much below the presence of early seral plants (50%). This indicates that increased management efforts here could lead to an improvement in short-term and eventually long-term ecological status.

Forb cover was the lowest (27%) in the *Bromus hordeaceus* series. It was split between annual species (19%) and perennial species (8%). This differed from the grass layer with 11% of the annual cover and 6% of the perennial cover being made up of native species. Forty-four percent of the plots in this type had > 20% cover of native forbs.

The long-term seral status of forb species also shows an unbalanced composition similar to that of the grass layer. It included mean forb cover of 18% early, 6% mid and 2% late seral species. Thirty-three percent of the plots had > 20% cover of early seral species, while none of the mid or late seral plots had > 20% cover.

Management Emphasis Rating:
The management emphasis rating for this type was generally high. This was due to high bare ground, high surface gravel and rock, high cover of noxious and invasive weeds and cover of high disturbance species.

Site Potential:
This type contains several native perennial and annual grass species of low constancy and cover. These include *Melica aristata, Poa secunda, Achnatherum lemmonii* and *Vulpia microstachys*. These species can be considered as remnants of the past community and should be considered as long-term restoration objectives. Due to the dry site conditions found in this type it is likely that *Achnatherum lemmonii* and *Vulpia microstachys* played a prominent role in the native plant community.

Closely Related Types:
This type is closely related to the *Cynosurus echinatus-Bromus hordeaceus-Bromus tectorum* type. They differ in the more coastal location, gentler slopes, tendency toward upper 1/3 slope positions, linear/concave vertical micro-relief and lower bare ground cover of the latter type.

Noxious Weeds:
This plant association contained moderate cover of the Cal EPPC List A1 noxious weed, cheatgrass (*Bromus tectorum*, 12%) on 100% of the plots and medusahead (*Taeniatherum caput-medusae*, 9%) on 33% of the plots.

MANAGEMENT IMPLICATIONS

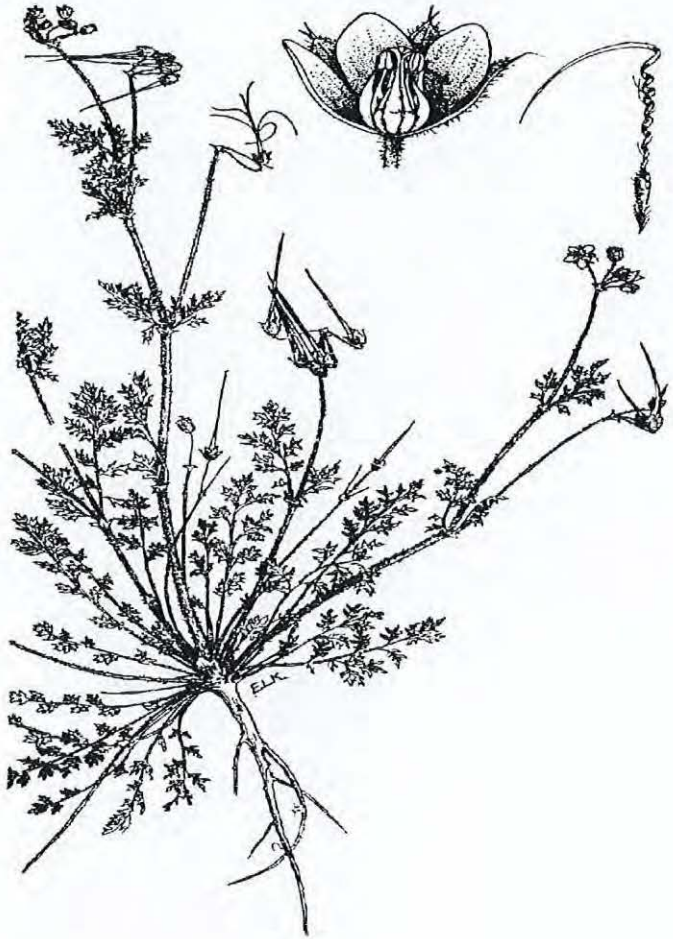
This type had the highest frequency of high bare ground (> 20%) plots in the alliance (55%). In addition, forty-four percent of the plots had > 20% surface cover of gravel and rock along with low litter cover (< 10) on senty-eight percent of the plots. These areas will require recovery time in order to improve litter cover and prevent exceeding Region 5 soil erosion standards. As a result of this it is suggested that this type be withdrawn from active grazing until the amount of bare ground drops below 5%. As an intermediate management step, exclosures could be constructed to determine site productivity and forage utilization levels. This would allow determination of site capability.

Fifty-six percent of the plots in this type had > 10 percent cover of noxious and invasive weeds. After an evaluation of the soil conditions and productivity, determine if the following standards for medusahead (*Taeniatherum caput-medusae*) can be applied. Recommended treatments against medusahead infestations include: controlled burning in late spring when seeds are still immature, "flash" grazing or heavy grazing during spring before seeds heads form, especially in areas previously burned, and restoration using squirrel-tail (*Elymus elymoides*). Successful eradication of large infestations of medusahead has not been demonstrated. It is imperative that small populations be controlled before they explode. Burning could lead to temporary increases in bare ground exposure so this will need evaluation prior to applying this management treatment.

Large infestations of cheatgrass (*Bromus tectorum*) are best addressed by subjecting the population to a combination of treatments to keep it under constant stress, each treatment reinforcing the others. These include: 1) prescribed burning in summer/fall to destroy the seed crop; 2) carefully timed grazing; 3) reseeding with native perennials to provide competition; and 4) herbicides. There are no known biological controls.

The aim is to eliminate new seed production and deplete the existing seedbank, and then develop management practices that deter re-infestation. Any eradication program should be expected to be long term, as noxious weeds have large seedbanks that will allow the population to reestablish itself for several years.

Plant Association: ***Bromus hordeaceus/Erodium botrys***
Soft Chess/Long-beaked Storksbill
EDP Code: **BRHO2/ERBO Association**
EcoCode: **GASCFX06**



Indicator Species:
***Erodium* sp. (Storksbill)**: These non-native, annual forbs were found on hot, inland sites, in upper and middle 1/3 slopes, with convex/linear micro-relief and shallow to deep soils, low rainfall and low litter cover.

Bromus hordeaceus/Erodium botrys
Soft Chess/Longbeaked Storksbill
BRHO2/ERBO Association, EcoCode: GASCFX06
Wildlife Habitat Relationship Type: Annual Grassland

SUMMARY TABLE
(Sample size: 10)

Species Richness: 22.0
Shannon Index: 2.1

Environment:
Distance to the Ocean: 49-60 mi.;
Elevation: 3030-4930 ft.;
Aspect: South;
Slope: 15-45%;
Slope Position: Middle 1/3, Upper 1/3;
Micro-relief:
Horizontal: concave/undulating, linear;
Vertical: linear, concave/undulating;
Bare ground: 1-10%;
Surface Rock: 0-12%;
Litter Cover: 1-35%

Ecological Status (Mean % Cover):

	Grasses	Forbs
Ann. Native	2.1	17.4
Ann. Exotic	58.8	36.4
Perenn. Native	9.0	3.8
Perenn. Exotic	0.1	0.2

Seral Status:	R5 Grasses	1-5 Year	R5 Forbs
Early	61.0	8.4	43.7
Mid	1.0	5.9	12.2
Late	2.2	47.1	1.4

Soils:
Pit Depth: 16-60 in.;
AWC: 2.0-3.1in;
Parent Material: Sandstone;
A Horizon:
Coarse Fragments: 5-40%;
Textures: GL, CL, GCL;
Clay content: 14-30%;
Thickness: 6-22 in.;
Surface pH: 6.5-7.2;
Depth to Argillic Horizon: 34 inches

		% COVER RANGE	MEAN	CON
Tree Overstory Layer				
None				
Tree Understory Layer				
None				
Shrubs				
None				
Forbs				
ERBO	*Erodium botrys*	0-35	10	90
TRIFO	*Trifolium* sp.	0-15	4	70
LOHU2	*Lotus humistratus*	0-10	4	70
PLAGI	*Plagiobothrys* sp.	0-5	2	70
GAPA5	*Galium parisiense*	0-10	3	40
GRCA	*Grindelia camporum*	0-4	2	40
LUNA	*Lupinus nanus*	0-5	2	40
CLARK	*Clarkia* sp.	0-1	1	40
CEGL2	*Cerastium glomeratum*	0-1	1	40
ERSE3	*Eremocarpus setigerus*	0-1	1	40
PLAGI	*Plagiobothrys* sp.	0-1	1	40
MICAC2	*Micropus californicus* var. *c.*	0-15	7	30
AGOSE	*Agoseris* sp.	0-2	2	30
MADIA	*Madia* sp.	0-2	1	30
DICAC5	*Dichelostemma capitatum* ssp. *c.*	0-1	1	30
DRVE	*Draba verna*	0-1	1	30
LINAN2	*Linanthus* sp.	0-1	1	30
SABI3	*Sanicula bipinnatifida*	0-1	1	30
Noxious Weeds				
CESO3	*Centaurea solstitialis*	0-40	28	30
Total Forb Cover		25-95	58	100
Graminoids				
BRHO2	*Bromus hordeaceus*	5-65	19	100
AVFA	*Avena fatua*	1-45	15	90
BRDI3	*Bromus diandrus*	0-90	15	70
VUMY	*Vulpia myuros*	0-8	2	60
AICA	*Aira caryophyllea*	0-5	2	40
VUMI	*Vulpia microstachys*	0-10	3	50
JUBU	*Juncus bufonius*	0-2	1	30
MELIC	*Melica* sp.	0-1	1	30
ACLE8	*Achnatherum lemmonii*	0-2	1	30
Noxious Weeds				
BRMAR	*Bromus madritensis* ssp. *rubens*	0-17	10	40
TACA8	*Taeniatherum caput-medusae*	0-1	1	10
Total Graminoid Cover		30-95	70	100

PHYSICAL AND BIOLOGICAL ENVIRONMENT

Distribution/Setting:

This plant association was found in the Eastern and Central Franciscan subsections of the Northern California Coast Ranges Section of the National Hierarchy. Sites were located on the Grindstone (Stonyford and Corning) Ranger district of the Mendocino National Forest. Mean distance to the Pacific Ocean was 57.0 miles, highest of all types in the *Bromus hordeaceus* series. It ranged from 52.0-60.2 miles inland.

Elevation averaged 3601 feet, second highest in the *Bromus hordeaceus* alliance. It had a range of 1890 to 4930 feet. Mean annual precipitation averaged 48 inches, lowest in the series. Slopes were moderately steep, averaging 29% and ranging from 4-45%. Aspects were south facing with a hot mean annual radiation index of .550. Aspect effects were moderated somewhat by middle 1/3 slope micro-position and its related topographic shading.

Sites were located primarily in the middle and upper 1/3 slope positions with linear/ concave horizontal micro-relief and linear/undulating micro-relief. These factors lead water to flow though and collect on concave sites.

Soil Summary:

Soils in this type were found in the thermic (55%) and mesic (45%) temperature regimes. Soil depth was deep (36%), moderately deep (36%) and shallow (28%). Soil drainage was somewhat excessively drained and well drained. They formed in residuum and colluvium from sandstone, sedimentary rocks. The litter layer had an average thickness of 1.2 inches at 13% cover. Bare ground averaged 7% and ranged from (1-10%). Surface rock and gravel averaged 5% cover and ranged from 0-12%. The surface horizon averaged 11 inches thick and ranged from 6-22 inches thick. Surface colors were 10YR 4/2 (dark grayish brown), 10YR 3/2 (very dark grayish brown) and 10YR 5/2 (grayish brown). They had gravelly loam, clay loam and gravelly clay loam textures. Coarse fragment content averaged 22% and ranged from 5-40%. Clay content averaged 22% and ranged from 14-30%. Soil pH averaged 6.8, neutral and ranged from 6.5-7-2.

The subsoils had gravelly clay loam and very gravelly clay loam textures. Subsoil colors were 10YR 6/3 (pale brown), 10YR 5/3 (brown) and 10YR 5/4 (yellowish brown). Subsoil coarse fragment content averaged 33% and ranged from 10% to 40%. Subsurface clay content averaged 30% and ranged from 18% to 35%. Subsurface pH averaged 6.8, neutral and ranged from 6.3 to 7.8. The soils were 55% skeletal. Soil AWC averaged 2.5 inches and ranged from 2.0 inches to 3.1 inches. The soils were classified into the subgroups Dystric Xerochrepts, Ultic Haploxerolls and Typic Endoaquolls.

Argillic horizons were infrequent on 9% of the plots in this type and averaged 34 inches in depth. This type was found primarily in middle 1/3 slopes with linear, convex and undulating micro-relief, moderate slopes, low bare ground cover, low surface rock and gravel cover. These factors together with the relative lack of argillic horizons contribute to the high total vegetation cover, second highest in the *Bromus hordeaceus* alliance, and high grass and forb cover.

Vegetation Summary:

Total vegetation cover averaged 85% and consisted of grasses (70%) and forbs (58%). Both the tree layer and shrub layer were absent. The forb layer was dominated by long-beaked storksbill (*Erodium botrys,* 10%) with a variety of clovers (*Trifolium* spp., 4%), small-podded lotus (*Lotus humistratus,* 4%) and popcorn flower (*Plagiobothrys* sp., 2%) as common associates. Soft chess (*Bromus hordeaceus,* 19%) dominated the diverse grass layer, which often included common wildoats

(*Avena fatua*, 90%) and ripgut brome (*Bromus diandrus*, 15%).

Species Richness:
Mean species richness was 21.2 species/plot, second highest in the *Bromus hordeaceus* alliance. Shannon diversity index was 2.0. Native grass species diversity was 2.2 species/plot, highest in the series. It appears to have been least affected by non-native grass competition. For example, only 10% of the 10 plots sampled in this type had no native grasses while 20% had only one native grass species present. Non-native grasses still dominated the grass layer with an average of 5.2 species/plot. Forb species diversity is reversed with an average of 10.1 native species/plot and 4.5 non-native species/plot.

Ecological Status:
This type had moderate cover of grasses (70%) within the *Bromus hordeaceus* alliance. Grass cover was split between annual species (61%) and perennial species (9%). Almost all of the annual grass cover was made up of non-native species (59%), while perennial grass cover was primarily native species (9%). Five of the 12 plots in this type had > 10% cover of perennial native grass species. These plots indicate site potential to support greater cover of late-seral native perennial grasses for the type.

The grass layer seral status (long-term) points toward the dominance of cover in early seral species (61%). This was the third highest mean early seral cover in the *Bromus hordeaceus* alliance. It had low cover in mid seral species (1%) and late seral grass species (2%). Forty-one percent of these plots had > 10% cover of mid seral species.

In the short-term (1-5 years) disturbance species composition had the best balance in the *Bromus hordeaceus* alliance. It had low mean cover of high disturbance grass species (8%), low cover of medium disturbance species (6%) and high cover of low disturbance species (47%). One hundred percent of the plots had > 20% low disturbance species cover and fifty percent had > 40% cover of low disturbance species. This is likely related to reduced disturbance by cattle grazing as stocking rates have declined. Historical impacts of cattle grazing appear to have been higher as indicated by only 4% cover of late seral species. This is further supported by the fact that cover of high disturbace species (8%) is much below the cover of early seral plants (61%). This indicates that increased management efforts here could lead to an improvement in long-term ecological status. It also indicates light to moderate grazing history in the last 3-5 years.

Forb cover was high (58%) in this plant association and was split between annual species (48%) and perennial species (4%). This was similar to the grass layer with 17% of the annual cover and 4% of the perennial cover being made up of native species. Fifty-eight percent of the plots in this type had > 20% cover of native forbs and 17% had > 40% cover of native forbs.

The long-term seral status of forb species also shows an unbalanced composition similar to that of the grass layer. It included mean forb cover of 44% early, 12% mid and 1% late seral species. Sixty-seven percent of the plots had > 20% cover of early seral species and 25% of the mid seral plots had > 20% cover.

Management Emphasis Rating:
The management emphasis rating for this type was generally low with an occasional high rating. Low ratings were due to low bare ground, low surface gravel and rock and a high cover of low disturbance species. High ratings were due to a limited number of plots with high bare round and high noxious and invasive weed cover. The low emphasis plots could serve as a model for management in this type.

Site Potential:
This type contains a host of native perennial and annual grass species of low constancy and cover. These include *Carex* sp., *Elymus glaucus, Juncus bufonius, Juncus mexicanus, Melica* spp., *Poa secunda, Achnatherum lemmonii, Nassella pulchra* and *Vulpia microstachys*. These species can be considered as remnants of the past community and should be considered as long-term restoration objectives.

Closely Related Types:
This type is closely related to the *Bromus hordeaceus-Taeniatherum caput-medusae/ Erodium botrys* type. They differ in the more coastal position, lower elevation, cooler aspects and lower forb cover of the latter.

Noxious Weeds:
Several Cal-EPPC List A1 noxious weeds were found in this type. High cover of yellow starthistle (*Centaurea solstitialis*, 28%) was found on 30% of the plots, and red brome (*Bromus madritensis* ssp. *rubens*, 10%) was found on 40% of the plots. Low cover of medusahead (*Taeniatherum caput-medusae*, 1%) was found on one of the Grindstone plots.

MANAGEMENT IMPLICATIONS:

Twenty-two percent of the plots in this type had $\geq$ 20% bare ground. These same plots had high cover of surface gravel and rock and low litter cover. They will require recovery time in order to prevent exceeding Region 5 soil erosion standards.

Twenty-five percent of the plots in this type had soils rated as having a high to moderate sensitivity to compaction.

To reduce large infestations of yellow star-thistle (*Centaurea solstitialis*), several controls have been utilized by land managers with varying success, the best success achieved when methods are used in combination. All are long-term endeavors that must be maintained over time. These include: 1) biological control by means of the hairy weevil and/or seedhead fly; 2) controlled grazing by cattle or sheep timed to specific stages of yellow star-thistle development; 3) mowing timed to specific stages of yellow star-thistle development and repeated at least once per season; 4) prescribed burning in late spring timed to specific stage of yellow star-thistle development; and 5) herbicides.

Recommended treatments against medusahead (*Taeniatherum caput-medusae*) infestations include: controlled burning in late spring when seeds are still immature, "flash" grazing or heavy grazing during spring before seeds heads form, especially in areas previously burned, and restoration using squirrel-tail (*Elymus elymoides*). Successful eradication of large infestations of medusahead has not been demonstrated. It is imperative that small populations be controlled before they explode.

Small infestations of red brome *(Bromus madritensis* spp. *rubens*) can be eliminated by manual removal. Leaving the pulled plants in place as a surface mulch would shade the soil, impeding further germination from the seed bank. Late fall burning in conjunction with sowing of perennial grasses is suggested for larger infestations. Red brome is shallow-rooted and shade-intolerant; therefore grazing and burning without sowing and/or mulching may increase its abundance.

The aim is to eliminate new seed production and deplete the existing seedbank, and then develop management practices that deter re-infestation. Any eradication program should be expected to be long term, as noxious weeds have large seedbank that will allow the population to reestablish itself for several years.

Plant Association: ***Bromus hordeaceus/Dichelostemma multiflorum-Grindelia camporum***
Soft Chess/Wild Hyacinth-Great Valley Resinweed
EDP Code: **BRHO2/DIMU5-GRCA Association**
EcoCode: **GASCFX07**

Bromus hordeaceus/Dichelostemma multiflorum-Grindelia camporum
Soft Chess/Wild Hyacinth-Great Valley Resinweed
BRHO2/DIMU5-GRCA Association, EcoCode: GASCFX07
Wildlife Habitat Relationship Type: Annual Grassland

SUMMARY TABLE
(Sample size: 5)

Species Richness:
21.0
Shannon Index: 2.1

Environment:
Distance to the Ocean: 54-56 mi.;
Elevation: 3150-4420 ft.;
Aspect: South, East;
Slope: 15-35%;
Slope Position: Middle 1/3;
Micro-relief:
Horizontal: convex, linear, undulating;
Vertical: undulating, convex, linear;
Bare ground: 1-6%;
Surface Rock: 0-5%;
Litter Cover: 0-1%

Ecological Status (Mean % Cover):

	Grasses	Forbs
Ann. Native	0.2	9.2
Ann. Exotic	56.8	7.6
Perenn. Native	24.6	9.2
Perenn. Exotic	14.2	0.0

Seral Status:	R5 Grasses	1-5 Year	R5 Forbs
Early	49.0	8.6	18.4
Mid	10.8	0.6	4.0
Late	27.8	60.4	1.4

Soils:
No soils data were collected in this type.

		% COVER RANGE	MEAN	CON
Tree Overstory Layer				
None				
Tree Understory Layer				
None				
Shrubs				
None				
Forbs				
GRCA	*Grindelia camporum*	1-10	4	100
DIMU5	*Dichelostemma multiflorum*	1-1	1	100
TOAR	*Torilis arvensis*	0-15	6	80
LUNA	*Lupinus nanus*	0-3	2	80
ERODI	*Erodium* sp.	0-1	1	80
LOHU	*Lotus humistratus*	0-5	1	80
TRIFO	*Trifolium* sp.	0-5	3	60
CIRSI	*Cirsium* sp.	0-2	1	60
CLARK	*Clarkia* sp.	0-1	1	60
EPBR3	*Epilobium brachycarpum*	0-1	1	60
VEAR	*Veronica arvensis*	0-1	1	40
VIAMA	*Vicia americana* var. *americana*	0-1	1	40
EQUIS	*Equisetum* sp.	0-10	10	20
DAPU3	*Daucus pusillus*	0-5	5	20
LIBI	*Linanthus bicolor*	0-5	5	20
MADIA	*Madia* sp.	0-5	5	20
Total Forb Cover		5-20	26	100
Graminoids				
BRHO2	*Bromus hordeaceus*	20-30	28	100
ACLE8	*Achnatherum lemmonii*	0-30	12	80
POA	*Poa* sp.	0-40	10	80
AVFA	*Avena fatua*	0-5	3	60
VUMY	*Vulpia myuros*	0-30	16	40
ELGL	*Elymus glaucus*	0-10	6	40
BRDI3	*Bromus diandrus*	0-1	1	40
AICA	*Aira caryophyllea*	0-40	40	20
CAREX	*Carex* sp.	0-20	20	20
Noxious Weeds				
TACA8	*Taeniatherum caput-medusae*	0-45	19	60
BRTE	*Bromus tectorum*	0-1	1	60
BRMAR	*Bromus madritensis* ssp. *rubens*	0-1	1	20
Total Graminoid Cover		65-90	96	100

PHYSICAL AND BIOLOGICAL ENVIRONMENT

Distribution/Setting:

This plant association was found in the Eastern and Central Franciscan subsections of the Northern California Coast Ranges Section of the National Hierarchy. Sites were located on the Grindstone (Stonyford and Corning) Ranger district of the Mendocino National Forest. Mean distance to the Pacific Ocean was 55.0 miles. It ranged from 54.0-56.0 miles inland.

Elevation averaged 3994 feet, second highest in the *Bromus hordeaceus* alliance. It had a range of 3150 to 4420 feet. Mean annual precipitation averaged 41.0 inches. Slopes were moderately steep, averaging 23% and ranging from 15-35%. Aspects were south or east facing with a mean annual radiation index of .503. Aspect effects were moderated somewhat by middle 1/3 slope micro-position and its related topographic shading.

Sites were located primarily in the middle 1/3 slope positions with linear/convex horizontal micro-relief and undulating micro-relief.

Soil Summary:

No soils data were collected in this type.

Vegetation Summary:

Total vegetation cover averaged 96% and consisted of grasses (96%) and forbs (26%). Both the tree layer and shrub layer were essentially absent. Low cover of Great Valley resinweed (*Grindelia camporum*, 4%) and wild hyacinth (*Dichelostemma multiflorum*, 1%) was found in all plots, usually in association with European hedge-parsley (*Torilis arvensis*, 6%), sky lupine (*Lupinus nanus*, 2%) and shortpod lotus (*Lotus humistratus,* 1%). Soft chess (*Bromus hordeaceus*, 28%) dominated the diverse grass layer, which generally included moderate cover of Lemmon stipa (*Achnatherum lemmonii*, 12%) and low cover of wild oats (*Avena fatua*, 3% and *A. barbata*, 1%). High cover of the noxious weed, medusahead (*Taeniatherum caput-medusae*, 19%), was found on 60% of the plots.

Species Richness:

Mean species richness was 21.0 species/plot, fourth highest in the *Bromus hordeaceus* series. Shannon diversity index was 2.1. Native grass species diversity was 0.8 species/plot, and appears to have been affected by the aggressive nature of non-native grasses. For example, 50% of the 18 plots sampled in this type had no native grasses while an additional 22% had only one native grass species present. Conversely, non-native grasses dominated the grass layer with an average of 5.4 species/plot. In contrast, forb species diversity is reversed with an average of 13.8 native species/plot and 4.3 non-native species/plot.

Ecological Status:

This type had the highest cover of grasses (96%) in the *Bromus hordeaceus* series. Grass cover was split between annual species (57%) and perennial species (39%). Almost all of the annual grass cover was made up of non-native species (57%),

while perennial grass cover was primarily native species (25%). Three of the five plots in this type had > 10% cover of perennial native grass species.

The long-term successional grass status points toward a more balanced system with high cover of early seral species (49%), low cover of mid seral (11%) and moderate cover (28%) of late seral species. This points toward a higher cover of relictual native grasses. In fact, this is perhaps the least disturbed annual grassland type found in this study.

The short-term successional species status was well balanced. It had low mean cover of early seral species (9%), low cover of mid-seral species (1%) and high late seral species cover (60%). All of the plots had > 40% late seral species cover. This indicates that increased management efforts here could lead to an improvement in long-term ecological status.

Mean forb cover was moderate (26%) and was split between annual species (17%) and perennial species (9%). This differed substantially from the grass layer with 9% of the annual cover and 9% of the perennial cover being made up of native species. Twenty percent of the plots in this type had > 20% cover of native forbs.

The long-term successional status of forb species showed an unbalanced composition. It included mean cover of 18% early, 4% mid and 1% late seral species. Sixty percent of the plots had > 10% cover of early seral species, while none of the mid or late seral plots had > 10% cover.

Management Emphasis Rating:
The management emphasis rating for this type was generally low. This was due to low bare ground, exceptionally high litter cover, moderate cover of noxious and invasive exotic weeds, and relatively high cover of low short-term disturbance indicator species. Further analysis at the plot level should identify opportunities for treatment of localized weed infestations to check their spread.

Site Potential:
This type contains a host of native perennial and annual species of low constancy and cover. These include *Bromus carinatus, Carex* spp., *Melica* sp. *Elymus glaucus, Festuca idahoensis, Poa palustris, Stipa lemmonii, Poa secunda* and *Vulpia microstachys*. These species can be considered as remnants of the past community and should be considered in long-term restoration objectives. Current cover and constancy of *Bromus carinatus, Festuca idahoensis*, and *Stipa lemmonii* suggests that they were prominent members of the native plant community.

Closely Related Types:
This type is closely related to the *Bromus hordeaceus-Elymus caput-medusae/ Erodium botrys* type. They differ in the more inland position, higher elevation, warmer aspects and higher forb cover of the former.

Noxious Weeds:
From the Cal EPPC List A1 noxious weed list, high cover of medusahead (*Taeniatherum caput-medusae*, 19%) and low cover of cheatgrass (*Bromus tectorum*, 1%) was found on 60% of the plots, and 1% cover of red brome (*Bromus madritensis*) was found on 20% of the plots in this type.

MANAGEMENT IMPLICATIONS:
Management emphasis in this community needs to be directed at substantially reducing the noxious weed cover of *Taeniatherum caput-medusae* (medusahead) and *Bromus tectorum* (cheatgrass).

Medusahead grows in soils with high clay content, well developed profiles and in areas receiving runoff from infested areas. Its range and habitat overlap with soft chess (*Bromus hordeaceus*) and cheatgrass in California. Medusahead may displace cheatgrass in more mesic sites. Like cheatgrass, it is a winter annual, but germination rates and winter root growth are greater than for cheatgrass (which itself out competes most other grasses by its vigorous winter jumpstart). Long-distance dispersal of medusahead is credited to ungulate grazers.

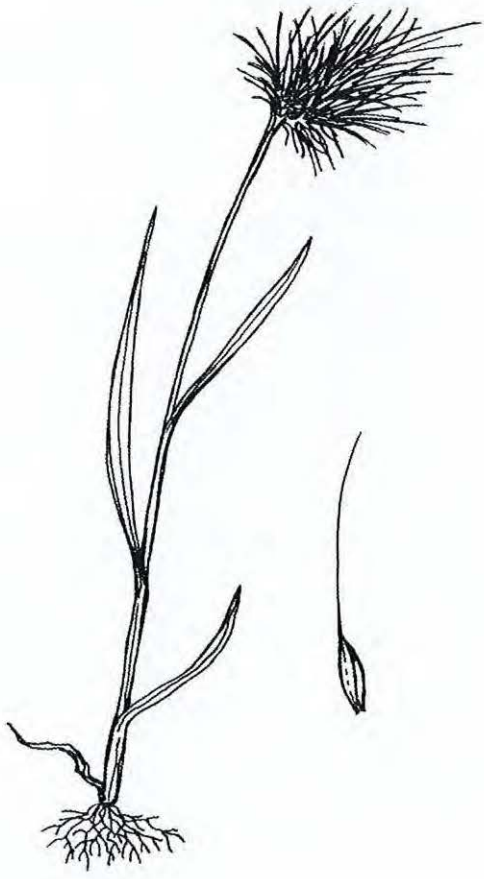
Recommended treatments against medusahead infestations include: controlled burning in late spring when seeds are still immature, "flash" grazing or heavy grazing during spring before seeds heads form, especially in areas previously burned, and restoration using squirrel-tail (*Elymus elymoides*). Successful eradication of large infestations of medusahead has not been demonstrated. It is imperative that small populations be controlled before they explode.

Large infestations of cheatgrass are best addressed by subjecting the population to a combination of treatments to keep it under constant stress, each treatment reinforcing the others. These include: 1) prescribed burning in summer/fall to destroy the seed crop; 2) carefully timed grazing; 3) reseeding with native perennials to provide competition; and 4) herbicides. There are no known biological controls.

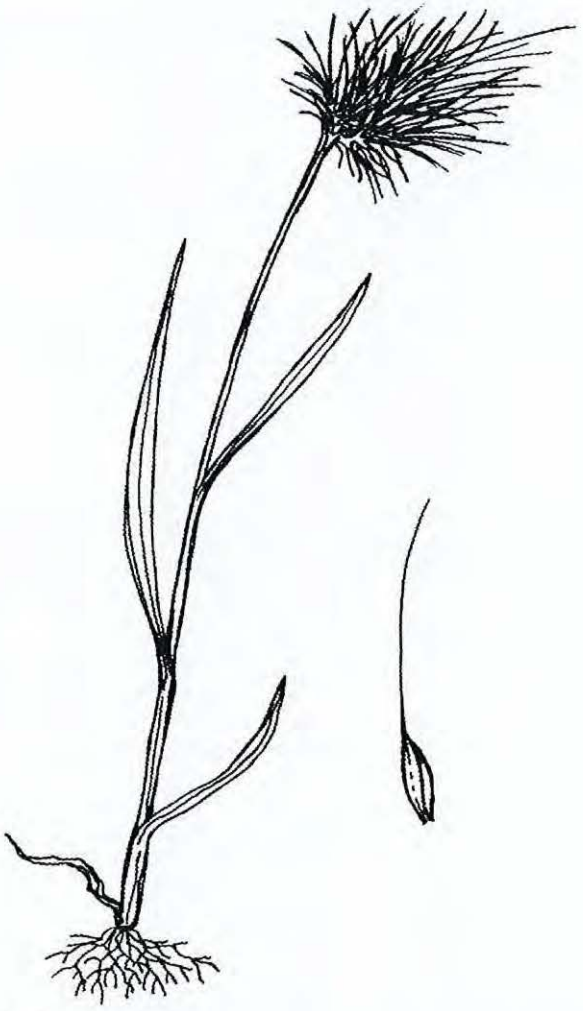
Small infestations of red brome (*Bromus madritensis* spp. *rubens*) can be eliminated by manual removal. Leaving the pulled plants in place as a surface mulch would shade the soil, impeding further germination from the seed bank. Late fall burning in conjunction with sowing of perennial grasses is suggested for larger infestations. Red brome is shallow-rooted and shade-intolerant; therefore grazing and burning without sowing and/or mulching may increase its abundance.

The aim is to eliminate new seed production and deplete the existing seedbank, and then develop management practices that deter re-infestation. Any eradication program should be expected to be long term, as noxious weeds have large seedbanks that will allow the population to reestablish itself for several years.

Cynosurus echinatus (Hedgehog-Dogtail) Alliance



Plant Association: ***Cynosurus echinatus-Bromus hordeaceus/***
Tarweed
Hedgehog-dogtail-SoftChess/Tarweed
EDP Code: **CYEC-BRHO2/HECOL-MAEL**
EcoCode: **GAHDFX01**



Indicator Species:

Cynosurus echinatus **(Hedgehog-dogtail):** This non-native annual grass species was the second most abundant grass in the Northern Province annual grasslands. It is an indicator of range deterioration and was found on inland, warm, southwest, south and east aspects, on upper elevation sites with moderate to high precipitation and high surface bare ground, gravel and rock. It matures later than most annual grasses; so early and heavy grazing allows hedgehog-dogtail to develop high cover with low competition.

Cynosurus echinatus-Bromus hordeaceus/Tarweed
CYEC-BRHO2/HECOL-MAEL Association, EcoCode: GAHDFXO1
Wildlife Habitat Relationships Type: Annual Grassland

SUMMARY TABLES
(Sample size: 15)

Species Richness: 23.8
Shannon Index: 2.2

Ecological Status (Mean % Cover):

	Grasses	Forbs
Ann. Native	0.0	45.3
Ann. Exotic	34.	1.9
Perenn. Native	8.5	7.9
Perenn. Exotic	2.0	1.9

Seral Status:	R5 Grasses	1-5 Year	R5 Forbs
Early	36.1	1.0	47.3
Mid	6.1	0.0	8.5
Late	2.6	16.4	1.7

Environment:
Distance to the Ocean: 36.7-37.4 mi.;
Elevation: 2940-3520 ft.;
Aspect: West, outlier Nortwest, South;
Slope: 15-45%;
Slope Position: Upper 1/3, Middle 1/3;
Micro-relief:
- Horizontal: linear, convex;
- Vertical: linear; convex;

Bare ground: 1-15%;
Surface Rock: 2-21%;
Litter Cover: 1-5%

Soils:
Pit Depth: 40+ in.;
AWC: 1.6-2.9 in.;
Parent Material: sandstone, chert;
A Horizon:
- Coarse Fragments: 12-31%;
- Textures: L, GL;
- Clay content; 16-30%;
- Thickness: 5-15 in.;

Surface pH: 5.7-6.7;
Depth to Argillic Horizon: 23 inches

		% COVER RANGE	MEAN	CON
Tree Overstory Layer				
None				
Tree Understory Layer				
None				
Shrubs				
None				
Forbs				
HECOL	*Hemizonia congesta* ssp. *luzulaefolia*	2-60	22	100
MADIA	*Madia spp.*	1-50	15	100
LODI	*Lomatium dissectum*	0-2	1	93
TRWI3	*Trifolium willdenovii*	0-5	2	80
DICAC5	*Dichelostemma capitatum* ssp. *c.*	0-1	1	80
TONO	*Torilis nodosa*	0-2	1	67
SIDI	*Sidalcea diploscytha*	0-5	2	53
TRLA16	*Tritelia laxa*	0-3	2	53
ACMI2	*Achillea millefolium*	0-5	1	53
TRBIB	*Trifolium bifidum* var. *bifidum*	0-1	1	53
VIAMA3	*Vicia americana* var. *americana*	0-1	1	47
WYAN	*Wyethia angustifolia*	0-25	6	40
AMIN	*Amsinkia intermedia*	0-1	1	40
CLARK	*Clarkia* sp.	0-3	1	40
RAOC	*Ranunculus occidentalis*	0-1	1	40
CASU3	*Calochortus superbus*	0-1	1	33
GALIU	*Galium* sp.	0-1	1	33
RUAC	*Rumex acetosella*	0-1	1	33
SABI3	*Sanicula bipinnatifida*	0-1	1	33
TRAL5	*Trifolium albopurpureum*	0-2	2	27
TRFU	*Trifolium fucatum*	0-2	2	27
RUCR	*Rumex crispus*	0-1	1	27
CAAT25	*Castilleja attenuata*	0-1	1	20
Noxious Weeds				
HYPE	*Hypericum perforatum*	0-2	1	80
Total Forb Cover		15-80	51	100
Graminoids				
CYEC	*Cynosurus echinatus*	1-40	16	100
BRHO2	*Bromus hordeaceus*	1-30	6	100
AVBA	*Avena barbata*	0-15	5	87
ELGL	*Elymus glaucus*	0-10	2	60
AICA	*Aira caryophyllea*	0-2	1	53
BRCA1	*Bromus carinatus*	0-15	6	40
POSE	*Poa secunda*	0-3	1	33
BRDI3	*Bromus diandrus*	0-2	1	27
DACAA	*Danthonia californica* var. *americana*	0-15	7	27
AREL3	*Arrhenatherum elatius*	0-25	9	20
BRJA	*Bromus japonicus*	0-15	6	20
Noxious Weeds				
TACA8	*Taeniatherum caput-medusae*	0-20	7	73
BRTE	*Bromus tectorum*	0-1	1	27
Total Graminoid Cover		20-70	43	100

PHYSICAL AND BIOLOGICAL ENVIRONMENT

Distribution/Setting:

This plant association was found in the Central Franciscan Subsection, in the northern portion of the Northern California Coast Ranges Section of the National Hierarchy. Sites were located on the Mad River Ranger District of the Six Rivers National Forest. Mean distance to the Pacific Ocean was 37.1 miles and ranged from 36.9 to 37.4 miles.

Elevation averaged 3282 feet and ranged from 2940 to 3520 feet. Mean annual precipitation averaged 65 inches and fell toward the high end of the *Cynosurus echinatus* alliance. Slopes were moderately steep, averaging 23% and ranging from 15-45%. Aspects were mainly west facing with limited plots that faced northwest and south. Mean annual radiation index was a relatively cool .476.

Sites were located primarily in the upper and middle 1/3 slope positions with linear/ convex horizontal and vertical micro-relief. These factors lead water to flow away from these sites and contribute to drier conditions.

Soil Summary:

Soils in this type were thermic (100%), deep (100%) and well drained. They formed in colluvium from sandstone and chert, sedimentary rocks. The litter layer had an average thickness of 0.4 inches at 1% cover. Bare ground averaged 3% and ranged from 1-15%. Surface rock and gravel averaged 9% cover and ranged from 2-21%. The surface horizon averaged 10 inches thick and ranged from 5-15 inches thick. It had loam and gravelly loam textures. Surface colors were 10YR 3/2 (very dark grayish brown) and 2.5Y 4/2 (dark grayish brown). Coarse fragment content averaged 19% and ranged from 12-31%. Clay content averaged 21% and ranged from 16-30%. Soil pH averaged 6.3, slightly acid and ranged from 5.7-6.7.

The subsoils had gravelly clay loam and extremely gravelly clay loam textures. Subsoil colors were 2.5Y 4/2 (dark grayish brown) and 10YR 3/2 (very dark grayish brown). Subsoil coarse fragment content averaged 40% and ranged from 20% to 70%. Subsurface clay content averaged 35% and ranged from 24% to 42%. Subsurface pH averaged 6.3, slightly acid and ranged from 5.5 to 6.7. The soils were 82% skeletal. Soil AWC averaged 2.4 inches and ranged from 1.6 inches to 2.9 inches. The soils were classified into the subgroups Typic Haploxeroll and Typic Xerorthent.

Argillic horizons were the primary diagnostic horizon in 73% of the plots. This horizon usually leads to drier conditions that influence grass cover by restriction of rooting depth. In this case, depth to the argillic horizon varied from 4 to 50 inches and averaged 23 inches. Moisture conditions were further influenced by the dry upper 1/3 slope positions. The result of this was the lowest grass cover and the highest forb cover in the *Cynosurus echinatus* series. The dominant forbs in this case were *Hemizonia congesta* ssp. *luzulaefolia* and *Madia elegans*. Both of these species have the ability to penetrate the argillic horizon with their taproots and access the available water found there.

Vegetation Summary:

Total vegetation cover was 93% and consisted of forbs (57%) and grasses (45%). Both the tree layer and shrub layer were missing. The forb layer was dominated by tarweeds, both *Hemizonia luzulaefolia* (22%) and *Madia elegans* (15%). Common associate species included lupines (*Lupinus* spp.), tomcat clover *(Trifolium wildenovii),* fernleaf lomatium *(Lomatium dissectum),* bluedicks *(Dichelostemma*

capitatum ssp. *capitatum),* and the noxious weed, St. John's wort *(Hypericum perforatum).* The grass layer was dominated by hedgehog-dogtail *(Cynosurus echinatus),* soft chess *(Bromus hordeaceus),* slender wildoats *(Avena barbata)* and the noxious weed, medusahead *(Taeniatherum caput-medusae)*

Species Richness:
Mean species richness in this type was 23.8, second highest in the annual grassland type. Shannon diversity index was 2.2, fifth highest in the annual grassland type. Native grass species diversity (1.9 species/plot) appears to have been affected by past grazing. Twenty-seven percent of the 15 plots sampled in this type had no native grasses while an additional 13% had only one native grass species present. Non-native grasses dominated the grass layer with an average of 5.7 species/plot. Forb species diversity was reversed with an average of 12.7 native species/plot, second highest in the annual grassland type. Non-native species/plot averaged 2.7, third lowest in the annual grassland types.

Ecological Status:
This type had the lowest mean grass cover (45%) in the annual grassland category. This is partially explained by the presence of a shallow argillic horizon that inhibits grass root penetration. Grass cover was split between annual species (34%) and perennial species (10%). All of the annual grass cover was made up of non-native species (34%); in fact no native annual grasses were identified in this type. Perennial grass cover was primarily native species (8%), with 40% of the plots containing native perennial cover from 11-31%.

The grass layer seral status (long-term) points toward the dominance of cover in early seral species (36%), with low cover in mid-seral species (6%) and late seral species (3%). Only twenty-seven percent of these plots had > 10% cover of mid seral species and seven percent had > 10% cover of late seral species.

In the short-term (1-5 years) the overall species composition is somewhat improved on some plots as indicated by the moderate cover (16%) of low disturbance related tall annual grasses. For instance, forty-seven percent of the plots had > 20% cover of low disturbance related species.

Forb cover was the second highest in the annual grassland category (57%). It was split between annual species (47%) and perennial species (10%). This differed substantially from the grass layer with 45% of the annual forb cover and 8% of the perennial forb cover being made up of native species. In fact only one plot contained native forb cover of < 15%.
The long-term seral status of forb species also shows a similar trend to that of grass species. It displays early seral forb species dominance with a mean cover of 47%, 8% mid seral and 2% late seral species. There were no examples of late seral forb cover to mimic and only four plots had > 10% cover of mid seral forbs

Management Emphasis Rating:
The management emphasis rating for this type was variable. This was due to high cover of surface and gravel and the hoccassional high cover of noxious and invasive weed species.

Site Potential:
This type contains a host of native perennial grass species of low to moderate constancy and cover. These include *Bromus carinatus, Danthonia californica, Elymus glaucus, Elymus elymoides, Juncus confusus, Luzula comosa, Luzula*

subcongesta and *Poa secunda.* These species can be considered as remnants of the past community and should be considered as long-term restoration objectives. Evidence from the Bald Hills of Redwood National Park suggests that *Bromus carinatus* and *Danthonia californica* were prominent members of the native plant community.

Closely Related Types:
Due to the high cover of tarweeds and the presence of shallow argillic horizons there were no types identified as closely related to this one.

Noxious Weeds:
One percent cover of cheatgrass (*Bromus tectorum*), a Cal-EPPC List A1 noxious weed, was found in 43% of the plots. Medusahead (*Taeniatherum caput-medusae*, 7%) and St. John's wort (*Hypericum perforatum,* 1%), on the same list, were found at 6% and 1% cover respectively in 71% of the plots in this plant association.

MANAGEMENT IMPLICATIONS:

Fifty percent of the plots in this type had soils rated as having a moderate sensitivity to compaction.

This community type indicates a history of grazing abuse with only unpalatable species dominance today. Presence of native perennial bunchgrasses including the genera *Danthonia*, *Melica*, *Elymus*, and *Poa* indicates possible remnant members of a formerly dominant grassland community. *Danthonia* would be the most likely target native perennial bunchgrass to formulate a restoration program around. Competition from *Cynosurus echinatus* would likely be the greatest challenge to using grazing management alone to improve the community. More intervention will likely be necessary to restore this community to even later seral non-native annual grasses such as *Bromus hordeaceus* and *Avena*s.

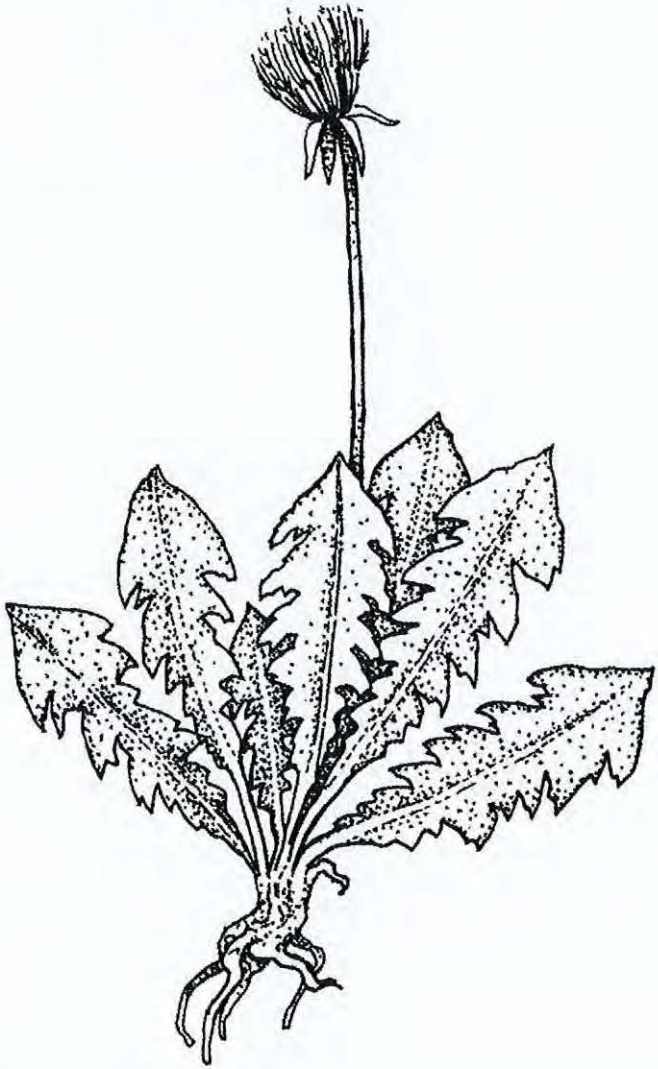
New infestations of cheatgrass (*Bromus tectorum*) should be dealt with before it becomes dominant and alters the water holding capacity of the soil surface.

Recommended treatments against medusahead (*Taeniatherum caput-medusae*) infestations include: controlled burning in late spring when seeds are still immature, "flash" grazing or heavy grazing during spring before seeds heads form, especially in areas previously burned, and restoration using squirrel-tail (*Elymus elymoides*). Successful eradication of large infestations of medusahead has not been demonstrated. It is imperative that small populations are controlled before they explode.

Bio-controls, including foliage and root-boring beetles have historically been successful in California in controlling St. John's wort *(Hypericum perforatum)*.

The aim is to eliminate new seed production and deplete the existing seedbank, and then develop management practices that deter re-infestation. Any eradication program should be expected to be long term, as noxious weeds have a large seedbank that will allow the population to reestablish itself for several years.

Plant Association: ***Cynosurus echinatus-Bromus hordeaceus (Bromus diandrus)/Taraxacum officinale***
Hedgehog-dogtail-SoftChess(Ripgut Brome) /CommonDandelion
EDP Code: **CYEC-BRHO2 (BRDI3)/TAOF**
EcoCode: **GAHDFX02**



Indicator Species:

***Taraxacum officinale* (Common Dandelion):** This non-native, perennial forb is often found in gully-drained soils of eroded meadows. These exotics indicate poor to very poor conditions and possibly previously denuded areas.

Cynosurus echinatus-Bromus hordeaceus (Bromus diandrus)/ Taraxacum officinale
Hedgehog-dogtail-Soft Chess(Ripgut Brome)/Common Dandelion
CYEC-BRHO2 (BRDI3)/TAOF Association, EcoCode:
Wildlife Habitat Relationships Type: Annual Grassland

SUMMARY TABLE
(Sample size: 6)

Species Richness: 20.5
Shannon Index: 2.0

Environment:
Distance to Ocean: 29-30 miles;
Elevation: 3050-3600 ft.;
Aspect: West, S.W., East;
Slope: 15-45%;
Slope Position: Upper 1/3;
Micro-relief:
  Horizontal: linear/concave;
  Vertical: linear;
Bare ground: 5-10%;
Surface Rock: 0-6%;
Litter Cover: 0-1%

Ecological Status (Mean % Cover):

	Grasses	Forbs
Ann. Native	0.0	14.0
Ann. Exotic	80.3	5.8
Perenn. Native	5.7	13.0
Perenn. Exotic	1.2	16.5

Seral Status:	R5 Grasses	1-5 Year	R5 Forbs
Early	80.5	2.2	38.5
Mid	6.3	0.2	9.3
Late	0.3	36.0	1.5

Soils:
Pit Depth: 40+in.;
AWC: 2.1-2.6 in.;
Parent Material: Sandstone;
A Horizon:
  Coarse Fragments: 15-20%;
  Textures: GL, GCL, GFSL;
  Clay content: 15-26%;
  Thickness: 2-6 in.;
Surface pH: 6.2-6.7
Depth to Argillic Horizon: 15 inches

		% COVER RANGE	MEAN	CON
Tree Overstory Layer				
None				
Tree Understory Layer				
None				
Shrubs				
None				
Forbs				
TAOF	*Taraxacum officinale*	1-15	9	100
LINAN	*Linanthus* sp.	0-15	7	83
CLARK	*Clarkia* sp.	0-5	4	83
ERODI	*Erodium* sp.	0-2	2	83
DICAC5	*Dichelostemma capitatum* ssp. *c.*	0-1	1	83
TRIFO	*Trifolium* sp.	0-2	1	83
SABI3	*Sanicula bipinnatifida*	0-10	5	67
PLBR6	*Plectritis brachystemon*	0-10	4	67
LODI	*Lomatium dissectum*	0-5	2	67
RAOC	*Ranunculus occidentalis*	0-3	2	67
HYRA3	*Hypochaeris radicata*	0-20	15	50
CEGL2	*Cerastium glomeratum*	0-1	1	50
CRIN8	*Cryptantha intermedia*	0-1	1	50
DAPU3	*Daucus pusillus*	0-5	3	33
CHPO3	*Chlorogalum pomeridianum*	0-1	1	33
LATHY	*Lathyrus* sp.	0-1	1	33
Noxious Weeds				
CESO3	*Centaurea solstitialis*	0-20	13	33
HYPE	*Hypericum perforatum*	0-2	2	33
Total Forb Cover		15-50	49	100
Graminoids				
CYEC	*Cynosurus echinatus*	30-60	47	100
BRHO2	*Bromus hordeaceus*	5-50	28	100
BRDI3	*Bromus diandrus*	1-5	2	100
ELGL	*Elymus glaucus*	0-10	4	83
POPR	*Poa pratensis*	0-2	2	67
BRCA5	*Bromus carinatus*	0-5	4	50
AICA	*Aira caryophyllea*	0-5	2	50
AVBA	*Avena barbata*	0-2	1	50
DACAA	*Danthonia californica* var. *americana*	0-2	2	33
Noxious Weeds				
BRTE	*Bromus tectorum*	0-5	3	33
BRMAR	*Bromus madritensis* ssp. *rubens*	0-1	1	17
TACA8	*Taeniatherum caput-medusae*	0-1	1	17
Total Graminoid Cover		70-80	87	100

PHYSICAL AND BIOLOGICAL ENVIRONMENT

Distribution/Setting:

This plant association was found in the Central Franciscan Subsection of the Northern California Coast Ranges Section of the National Hierarchy. Sites were located on the Mad River Ranger District of the Six Rivers National Forest. Mean distance to the Pacific Ocean was 29.7 miles, lowest in the *Cynosurus echinatus* alliance. It ranged from 28.9 to 30.1 miles inland.

Elevation averaged 3220 feet and ranged from 3050 to 3600 feet. Mean annual precipitation averaged 55 inches and was the lowest in the series. Slopes were moderately steep, averaging 29% and ranged from 15-45%. Aspects were southwest to west and east facing. Mean annual radiation index was a relatively cool .489.

Sites were located in upper 1/3 slope positions with linear/concave horizontal micro-relief and linear vertical micro-relief. The upper 1/3 slope position leads to exposed sites that are relatively dry.

Soil Summary:

Soils in this type were thermic (100%) and deep (100%). Soil drainage was well drained and moderately well drained. Soils formed in colluvium from sandstone, sedimentary rocks. The litter layer was practically non-existent in this community. Bare ground averaged 8% and ranged from (5-10%). Surface rock and gravel averaged 3% cover and ranged from 0-6%. The surface horizon averaged 5 inches thick and ranged from 2-6 inches thick. It had gravelly loam, gravelly clay loam and gravelly fine sandy loam textures. Surface colors were 2.5Y 6/2 (very dark grayish brown), 2.5Y 5/2 (grayish brown) and 10YR 5/3 (brown). Coarse fragment content averaged 17% and ranged from 15-20%. Clay content averaged 21% and ranged from 15-26%. Soil pH averaged 6.5, slightly acid, and ranged from 6.2-6.7.

The subsoils were cobbly silt loam and extremely stoney loams. Subsoil colors were 10YR 3/2 (very dark grayish brown) and 10YR 4/2 (dark grayish brown). Subsoil coarse fragment content averaged 27% and ranged from 14% to 40%. Subsurface clay content averaged 35% and ranged from 28% to 44%. Subsurface pH averaged 6.6 (neutral) and ranged from 6.4 to 6.7. The soils were 40% skeletal. Soil AWC averaged 2.4 inches and ranged from 2.1 inches to 2.6 inches. The soils were classified into the subgroups Ultic Haploxeralfs, Mollic Haploxeralfs and Ultic Haploxerolls.

Argillic horizons were the primary diagnostic horizon in 80% of the plots. This horizon usually leads to drier conditions that influence grass cover by its restriction of rooting depth. Depth to the argillic horizon varied from 12 to 19 inches and averaged 15 inches. Moisture conditions were also influenced by the dry upper 1/3 slope positions and moderately steep slopes. Micro-relief was undulating and linear, which compensated for the dry features described above. The result of this was the second highest grass cover in the *Cynosurus echinatus* alliance.

Vegetation Summary:

Total vegetation cover was high (90%) and was dominated by grasses (87%). Both the tree and shrub layers were absent. Total cover in the forb layer was 49%. Common dandelion (*Taraxacum officinale*, 9%) was dominant, frequently in association with (*Linanthus* sp., 7%), clovers (*Trifolium* spp., 1%), filaree (*Erodium* sp., 2%) and blue dicks (*Dichelostemma capitatum* ssp. *capitatum*, 1%). The grass layer was dominated by high cover of hedgehog-dogtail (*Cynosurus echinatus*,

47%) and soft chess (*Bromus hordeaceus*, 28%) with ripgut brome (*Bromus diandrus, 2%)*. Low cover of blue wildrye (*Elymus glaucus,* 4%) was generally present.

Species Richness:
Mean species richness was 20.5 species/plot, among the highest in the *Cynosurus echinatus* alliance. Shannon diversity index was 2.0. Native grass species diversity was 1.7 species/plot, third highest in the series. It appears to have been moderately affected by non-native grasses competition. For example, all six plots sampled in this type had native grasses with 33% having only one native grass species present. Non-native grasses still dominated the grass layer with an average of 5.8 species/ plot. Forb species diversity was high here with an average of 9.7 native species/ plot and only 3.2 non-native species/plot.

Ecological Status:
This type had the highest mean grass cover (87%) in the *Cynosurus echinatus* alliance. Grass cover was split between annual (80%) and perennial species (7%). All of the annual grass cover was made up of non-native species (80%); in fact no native annual grasses were identified in this type. Perennial grass cover was primarily native species (6%), with one of the plots containing > 10% native perennial cover.

The grass layer seral status (long-term) points toward the dominance of cover in early seral species (80%), with low cover in mid-seral species (6%) and late seral species (< 1%). Only twenty-three percent of these plots had > 10% cover of mid and late seral species.

In the short-term (1-5 years) the overall species composition is dramatically mproved. High disturbance grass species cover was low (2%), second lowest in the *Cynosurus echinatus* series. Medium disturbance grass cover was also low (< 1%), while low disturbance cover of tall annual grasses was the second highest (36%) in the *Cynosurus* alliance. This is likely related to reduced disturbance by cattle grazing as stocking rates have declined. Historical impacts of cattle grazing appear to have been higher as indicated by < 1% cover of late seral species. This is further supported by the fact that cover of high disturbace species (2%) is much below the presence of early seral plants (80%). This indicates that increased management efforts here could lead to an improvement in short-term and eventually long-term ecological status.

Forb cover was the second highest in the *Cynosurus echinatus* alliance (49%). It was split between annual species (20%) and perennial species (29%). Perennial forb cover was the highest in the alliance. This differed substantially from the grass layer with 14% of the annual forb cover and 13% of the perennial forb cover being made up of native species. Eighty-three percent of the plots had > 20% cover of native forbs and seventeen percent had > 40% cover of native forbs.

The long-term seral status of forb species hows an unbalanced composition of seral stages. It included 39% mean cover of early seral species, 9% mean cover of mid seral and 2% late seral species. There were no examples of late seral forb cover to mimic and only two plots had > 10% cover of mid seral forbs.

Management Emphasis Rating:
The management emphasis rating for this type was moderate. This was due to the moderate cover of bare ground (10-20%) and infrequent high cover of noxious

and invasive weeds.

Site Potential:
This type contained several native perennial grass species of low to moderate constancy and cover. These include *Bromus carinatus*, *Danthonia californica*, *Elymus glaucus*, *Juncus spp.* and *Luzula comosa*. These species can be considered as remnants of the past community and should be considered as long-term restoration objectives.

Closely Related Types:
This type was most similar to the *Cynosurus echinatus-Bromus hordeaceus/Avena fatua* type. They differed in the higher precipitation, closer proximity to the Pacific Ocean, middle 1/3 micro-position, concave/undulating horizontal micro-relief, low bare ground cover, higher radiation index and more southerly position along the Y axis.

Noxious Weeds:
Several noxious weeds were found in this plant association. For instance, in 33% of the plots, yellow starthistle (*Centaurea solstitialis*) was found at 13% cover, St. John's wort (*Hypericum perforatum*) was found at 2% cover and cheatgrass (*Bromus tectorum*) was found at 3% cover. Medusahead (*Taeniatherum caput-medusae*) was found at 1% cover in 17% of the plots.

MANAGEMENT IMPLICATIONS:

Bare ground cover is primarily rated as moderate here. It is recommended that management actions be directed toward preventing any further increase. Small infestations of cheatgrass (*Bromus tectorum*) should be dealt with before it becomes dominant and alters the water holding capacity of the soil surface.

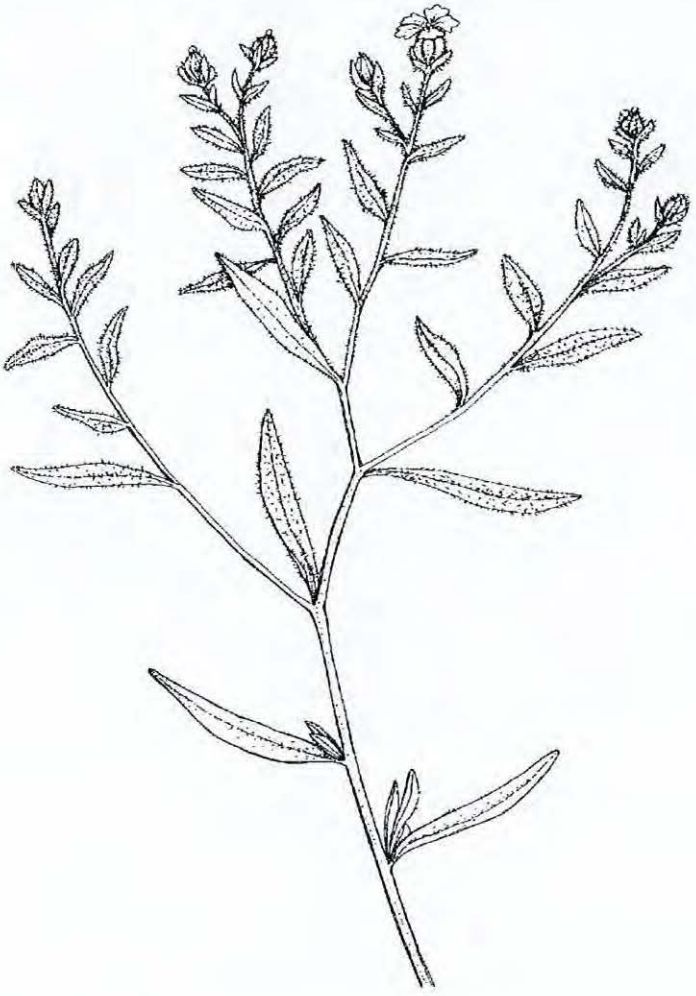
Recommended treatments against medusahead (*Taeniatherum caput-medusae*) infestations include: controlled burning in late spring when seeds are still immature, "flash" grazing or heavy grazing during spring before seeds heads form, especially in areas previously burned, and restoration using squirrel-tail (*Elymus elymoides*). Successful eradication of large infestations of medusahead has not been demonstrated. It is imperative that small populations are controlled before they explode.

Bio-controls, including foliage and root-boring beetles have historically been successful in California in controlling St. John's wort (*Hypericum perforatum*).

To reduce large infestations of yellow star-thistle, several controls have been utilized by land managers with varying success, the best success achieved when methods are used in combination. All are long-term endeavors that must be maintained over time. These include: 1) biological control by means of the hairy weevil and/or seedhead fly; 2) controlled grazing by cattle or sheep timed to specific stages of yellow star-thistle development; 3) mowing timed to specific stages of yellow star-thistle development and repeated at least once per season; 4) prescribed burning in late spring timed to specific stage of yellow star-thistle development; and 5) herbicides.

The aim is to eliminate new seed production and deplete the existing seedbank, and then develop management practices that deter re-infestation. Any eradication program should be expected to be long term, as noxious weeds have a large seedbank that will allow the population to reestablish itself for several years.

Plant Association: ***Cynosurus echinatus/Lagophylla*** **sp.//Rocky Hedgehog-dogtail/Hareleaf//Rocky**
EDP Code: **CYEC/LAGOP//Rocky**
EcoCode: **GAHDFX03**



Indicator Species:

Lagophylla **sp. (Hareleaf):** This annual, native forb is found on dry ridgetops and upper 1/3 slopes with convex and linear slope shapes and a high percentage of bare ground, surface rock and gravel.

***Cynosurus echinatus/Lagophylla*/Rocky**
Hedgehog-dogtail/Hareleaf//Rocky
CYEC/LAGOP//Rock Association, EcoCode: GAHDFX03
Wildlife Habitat Relationships Type: Annual Grassland

SUMMARY TABLE
(Sample size: 12)

Species Richness: 17.2

Shannon Index: 1.8

Environment:
Distance to the Ocean: 32-37 mi.;
Elevation: 3400-4360 ft.;
Aspect:. South, East;
Slope: 25-45%;
Slope Position: Upper 1/3, Middle 1/3, Lower 1/3;
Micro-relief:
Horizontal: undulating/linear;
Vertical: undulating/linear;
Bare ground: 1-10%;
Surface Rock: 3-95%;
Litter Cover: 0-95%

Ecological Status (Mean % Cover):

	Grasses	Forbs
Ann. Native	0.0	15.3
Ann. Exotic	74.3	0.2
Perenn. Native	6.6	10.0
Perenn. Exotic	0.0	6.2

Seral Status:	R5 Grasses	1-5 Year	R5 Forbs
Early	74.7	11.1	19.9
Mid	3.0	0.0	5.4
Late	3.3	16.7	5.8

Soils:
Pit Depth: 22-31 in.;
AWC: 2.3-3.4 in.;
Parent Material: Sandstone;
A Horizon:
Coarse Fragments: 7-75%
Textures: GSIL, GL;
Clay content: 6-18%;
Thickness: 3-16in;
Surface pH: 5.5-7.0;
Depth to Argillic Horizon: 8 inches

		% COVER RANGE	MEAN	CON
Tree Overstory Layer				
None				
Tree Understory Layer				
None				
Shrubs				
SYMO	*Symphoricarpus mollis*	0-2	2	17
RUBUS	*Rubus* sp.	0-1	1	17
Total Shrub Cover		0-2	1	100
Forbs				
LAGOP	*Lagophylla* sp.	1-25	7	100
ACMI2	*Achillea millefolium*	0-10	5	75
BRODI	*Brodiaea* sp.	0-5	2	67
RUAC	*Rumex acetosella*	0-3	2	58
CLPUQ	*Clarkia purpurea* var. *quadrivulnera*	0-10	4	50
TAOF	*Taraxacum officinale*	0-2	1	58
HACA	*Hackelia californica*	0-1	1	50
CHPO3	*Chlorogalum pomeridianum*	0-2	1	50
LOMAT	*Lomatium* sp.	0-1	1	50
CLAM	*Clarkia amoena*	0-5	5	33
CLARK	*Clarkia* sp.	0-5	3	33
LUPIN	*Lupinus* sp.	0-20	3	33
WYAN	*Wyethia angustifolia*	0-5	2	25
COLLO	*Collomia* sp,	0-1	1	25
MAOR3	*Marah oreganus*	0-2	1	25
VIAMA	*Vicia americana* var. *a.*	0-1	1	25
Total Forb Cover		10-60	32	100
Graminoids				
CYEC	*Cynosurus echinatus*	20-80	49	100
ELGL	*Elymus glaucus*	0-15	4	67
AVBA	*Avena barbata*	0-30	11	67
ACLE8	*Achnatherum lemmonii*	0-20	5	58
BRHO2	*Bromus hordeaceus*	1-2	2	58
AICA	*Aira caryophyllea*	0-25	11	50
BRDI3	*Bromus diandrus*	0-10	5	50
ELEL	*Elymus elymoides*	0-3	2	25
FEOC	*Festuca occidentalis*	0-2	1	25
Noxious Weeds				
BRTE	*Bromus tectorum*	0-25	9	58
Total Graminoid Cover		40-90	81	100

PHYSICAL AND BIOLOGICAL ENVIRONMENT

Distribution/Setting:

The plant association was found in the Eastern and Central Franciscan subsections of the Northern California Coast Ranges Section of the National Hierarchy. Sites were located on the Mad River Ranger District of the Six Rivers National Forest. Mean distance to the Pacific Ocean was 34.1 miles and ranged from 31.6 to 36.9 miles inland.

Elevation averaged 3813 feet highest in the *Cynosurus echinatus* alliance. Elevation ranged from 3400 to 4360 feet. Mean annual precipitation averaged 75.8 inches, second highest in the series. Slopes were steep, averaging 30% and ranging from 25-45%. Aspects were mainly south facing with limited plots that faced east. Mean annual radiation index was a warm .502.

Sites were located primarily in the upper and middle 1/3 slope positions with infrequent occurrences in the lower 1/3 slope position. Horizontal and vertical micro-relief were undulating/linear.

Soil Summary:

Soils in this type were mesic (100%) and moderately deep (100%). Soil drainage was somewhat excessively drained and well drained. They formed in residuum from sandstone, sedimentary rocks. The litter layer had an average thickness of 0.1 inches at 29% cover. Bare ground averaged 4% and ranged from 1-10%. Surface rock and gravel averaged 37% cover, highest in the *Cynosurus echinatus* alliance, and ranged from 3-95%. This high cover of surface gravel and rock is likely the effect of high past disturbance that has led to heavily eroded surfaces. The surface horizon averaged 8 inches thick and ranged from 3-16 inches thick. It had gravelly silty loam and gravelly loam textures. Surface colors were 10YR 3/2 (very dark grayish brown), 10YR 3/3 (dark brown), 10YR 4/2 (dark grayish brown) and 10YR 4/3 (dark brown). Coarse fragment content averaged 28% and ranged from 7-75%. Clay content averaged 10% and ranged from 6-18%. Soil pH averaged 6.1, slightly acid and ranged from 5.5-7.0.

The subsoils were cobbly silt loam and extremely stony loams. . Surface colors were 10YR 4/2 (dark grayish brown), 10YR 4/3 (dark brown) and 10YR 4/4 (dark yellowish brown). Subsoil coarse fragment content averaged 64%, highest in the *Cynosurus echinatus* alliance and ranged from 35% to 90%. Subsurface clay content averaged 18% and ranged from 8% to 32%. Subsurface pH averaged 6.1, slightly acid and ranged from 5.5 to 8.0. The soils were 83% skeletal. Soil AWC averaged 2.7 inches and ranged from 2.3 inches to 3.4 inches. The soils were classified into the subgroups Dystric Xerorthents, Dystric Xerochrepts, Mollic Haploxeralfs and Ultic Haploxeralfs.

Argillic horizons were found in 67% of the plots in this type. This horizon usually leads to drier conditions that influence grass cover by restriction of rooting depth. In this case, depth to the argillic horizon varied from 5 to 16 inches and averaged 8 inches. Moisture conditions were modified by middle 1/3 slope positions and undulating/linear micro-relief. The result of this was the highest grass cover and lowest forb cover in the *Cynosurus echinatus* alliance.

Vegetation Summary:
Total vegetation cover averaged 95% and was dominated by grasses (81%). The tree layer was absent. Creeping snowberry (*Symphoricarpus mollis*) represented the sparse shrub layer with 2% cover in 17% of the sites. The moderate (32%) cover of the forb layer was dominated by hareleaf (*Lagophylla* sp., 7%), usually in association with common yarrow (*Achillea millefolium*, 5%). High cover of hedgehog-dogtail (*Cynosurus echinatus*, 53%) dominated the grass layer and blue wildrye (*Elymus glaucus*, 4%), slender oats (*Avena barbata*, 11%) and Lemmon stipa (*Achnatherum lemmonii*, 5%) were its most common associates.

Species Richness:
Mean species richness was 17.2 species/plot, second lowest in the *Cynosurus echinatus* alliance. Shannon diversity index was 1.8. Native grass species diversity was 2.2 species/plot, highest in the series. It appears to have only been moderately affected by non-native grass competition, due to the harsh environment present here. For example, only 8% of the 12 plots sampled in this type had no native grasses, while 25% had only one native grass species present. Non-native grasses had their lowest richness in the series, but still dominated the grass layer with an average of 4.4 species/plot. Forb species diversity was moderate with an average of 7.8 native species/plot and 2.3 non-native species/plot.

Ecological Status:
This type had the highest mean grass cover (81%) in the *Cynosurus echinatus* alliance. Cover was split between annual (74%) and perennial species (7%). All of the annual grass cover was made up of non-native species (74%); ie, no native annual grasses were identified in this type. In contrast, almost all of the perennial grass cover was made up of native species (7%), with three of the plots containing > 10% native perennial cover.

The grass layer seral status (long-term) points toward the dominance of cover in early seral species (75%), with low (3%) cover in both mid-seral and late seral species. Only 8% of these plots had > 10% cover of mid and late seral species.

In the short-term (1-5 years) the overall species composition improves slightly as indicated by the moderate cover (17%) of low disturbance-related, tall annual grasses. This is likely related to reduced disturbance by cattle grazing as stocking rates have declined. Historical impacts of cattle grazing appear to have been higher as indicated by only 3% cover of late seral species. This is further supported by the fact that cover of high disturbance species (11%) is much below the cover of early seral plants (75%).

Forb cover fell within the middle of the *Cynosurus echinatus* alliance (32%). It was split between annual species (16%) and perennial species (16%). Perennial forb cover was the second highest in the series. This differed substantially from the grass layer with 15% of the annual forb cover and 10% of the perennial forb cover being made up of native species. Sixty-seven percent of the plots had > 20% cover of native forbs and 8% had > 40% cover of native forbs.

The long-term seral status of forb species also shows an unbalanced composition of seral states, including 20% mean cover of early seral forb species, 5% mean cover of mid seral and 6% late seral species. There were two examples of mid and late seral forb cover to mimic, and only 2 plots had > 10% cover of mid seral forbs.

Management Emphasis Rating:
The management emphasis rating for this type was high. This was due to the extremely high cover of surface gravel and rock (indicating heavily eroded surfaes), moderately unbalanced cover of high distrubance species and occassioanl high cover of noxious and invasive weed species.

Site Potential:
This type contains several native perennial grass species of low to moderate constancy and low cover. These include *Deschampsia elongata, Elymus glaucus, Elymus elymoides, Festuca californica, Festuca occidentalis* and *Achnatherum lemmonii.* These species can be considered as remnants of the past community and should be considered as long-term restoration objectives. Evidence from the Bald Hills of Redwood National Park suggests that *Danthonia californica* was a prominent member of the historic native plant community.

Closely Related Types:
The *Cynosurus echinatus/Lagophylla/l*Rock type is most closely related to the *Bromus hordeaceus-Aira caryophyllea/Erodium* sp. type. They differ in the higher rainfall, distance to the Pacific Ocean, elevation and surface gravel plus rock of the former type, and the hotter radiation index and forb cover in the *Bromus hordeaceus-Aira caryophyllea/Erodium* sp. type.

Noxious Weeds:
Low cover of the Cal-EPPC List A1 noxious weed, bull thistle (*Cirsium vulgare,* 1%) was found in 7% of the plots in this plant association.

MANAGEMENT IMPLICATIONS:

Seventy-five percent of the plots in this type had ≥ 20% surface cover of gravel and rock. This is likely the past result of heavily eroded surfaces. These areas will require recovery time in order to prevent further exceeding Region 5 soil erosion standards. One hundred percent of the plots in this type had soils rated as having a moderate to high sensitivity to compaction. Due to the high surface gravel and rock this type appears to be a good candidate for rest from livestock grazing.

It is likely the high surface soil fragment and rock content is serving as a mulch to reduce soil water evaporation. The high cover of *Cynosurus echinatus* (*Cynosurus*) and the presence of a relatively diverse set of native perennial grasses of low cover are dependent on the stored soil water in the upper and middle slope position. The high litter cover (29%) would indicate light current livestock grazing which may be due to the dominance of *Cynosurus* and lack of other palatable grass vegetation. The high cover of *Cynosurus* is extremely unusual in the Northern Province.

Grazing management scheduled to utilize *Cynosurus* prior to heading, followed by rest for the remainder of the growing season, would increase more desirable annual grasses such as *Avena barbata, Bromus diandrus* and *Bromus hordeaceus.* Repetition of this treatment over several years would favor reproduction and establishment of the native grasses present in the community. With successful increase of desirable annual grasses and reduction in abundance of *Cynosurus,* later season grazing should be employed to provide more light to regenerating native perennial grass seedlings over the years. The stocking rate should be carefully managed to not exceed 50% utilization of mature perennial grasses.

Plant Association: ***Cynosurus echinatus-Bromus hordeaceus-Avena fatua***
Hedgehog-dogtail-Soft Chess-Wildoat
EDP Code: **CYEC-BRHO2/AVFA**
EcoCode: **GAHDFX04**

Indicator Species:

***Avena fatua* (Wildoat):** This non-native, annual grass typically grows on open slopes and often dominates the grass layer in annual grasslands. It tends to simulate a climax type, but with close grazing is replaced with less palatable bromes and fescues. Wild oat is one of the most responsive of annual grasses to high soil fertility and moist but not wet soils. It can exceed eight feet in height under unusually prime conditions. It often shades out shorter-stature species and its litter keeps soils relatively cool, thereby not allowing heat dormancy triggering and germination of competing species.

Cynosurus echinatus-Bromus hordeaceus-Avena fatua
Hedgehog-dogtail-Soft Chess-Wildoat
CYEC-BRHO2/AVFA Association, EcoCode: GAHDFX04
Wildlife Habitat Relationships Type: Annual Grassland

SUMMARY TABLE
(Sample size: 10)

Species Richness: 19.2

Shannon Index: 2.1

Environment:
Distance to Ocean: 27-30 miles;
Elevation: 2100-3980 ft.;
Aspect: Southwest, Southeast;
Slope: 5-35%;
Slope Position: Mainly middle 1/3;
Micro-relief:
  Horizontal: undulating/linear;
  Vertical: convex/undulating;
Bare ground: 0-10%;
Surface Rock: 4-17%;
Litter Cover: 77-99%

Ecological Status (Mean % Cover):

	Grasses	Forbs
Ann. Native	0.0	14.5
Ann. Exotic	69.8	11.8
Perenn. Native	4.7	4.0
Perenn. Exotic	1.7	11.1

Seral Status:	R5 Grasses	1-5 Year	R5 Forbs
Early	71.0	5.7	34.8
Mid	4.4	0.0	5.0
Late	0.7	39.3	1.3

Soils:
Pit Depth: 21-40+ in.;
AWC: 1.8-3.3 in.;
Parent Material: Sandstone;
A Horizon:
  Coarse Fragments: 7-36%;
  Textures: L, GL, VGL;
  Clay content: 16-26%;
  Thickness: 4-17 in.;
Surface pH: 5.5-7.0
Depth to Argillic Horizon: 18 inches

		% COVER RANGE	MEAN	CON
Tree Overstory Layer				
None				
Tree Understory Layer				
None				
Shrubs				
TODI	*Toxicodendron diversilobum*	0-3	2	40
Total Shrub Cover		0-3	1	100
Forbs				
TAOF	*Taraxacum officinale*	1-12	3	100
LOMI	*Lotus micranthus*	0-30	12	80
PLLA	*Plantago* sp.	0-10	3	70
LIBI5	*Linum bienne*	0-4	2	70
MAMA	*Madia madioides*	0-2	1	70
RUAC	*Rumex acetosella*	1-25	7	60
ERCI6	*Erodium cicutarium*	0-30	7	50
CHPO3	*Chlorogalum pomeridianum*	0-1	1	40
LOMAT	*Lomatium* sp.	0-1	1	40
RAOC	*Ranunculus occidentalis*	0-2	1	40
SILEN	*Silene* sp.	0-2	1	40
MEPO3	*Medicago polymorpha*	0-25	18	30
TRMA2	*Trifolium macrei*	0-5	4	30
GNPU2	*Gnaphalium purpureum*	0-8	3	30
SHAR2	*Sherardia arvensis*	0-5	3	30
ACMI2	*Achillea millefolium*	0-2	2	30
AMIN3	*Amsinkia intermedia*	0-1	1	30
COAR	*Convolvulus arvensis*	0-1	1	30
DICAC5	*Dichelostemma capitatum* ssp. *c.*	0-2	1	30
MAOR3	*Marah oreganus*	0-10	6	20
Noxious Weeds				
CESO3	*Centaurea solstitialis*	0-1	1	30
HYPE	*Hypericum perforatum*	0-1	1	10
Total Forb Cover		20-60	41	100
Graminoids				
CYEC	*Cynosurus echinatus*	10-65	26	100
BRHO2	*Bromus hordeaceus*	2-60	21	90
AICA	*Aira caryophyllea*	0-15	5	80
AVFA	*Avena fatua*	0-25	13	70
BRDI3	*Bromus diandrus*	0-35	13	70
AREL3	*Arrhenatherum elatius*	0-3	2	40
POPR	*Poa pratensis*	0-1	1	40
DAGL	*Dactylis glomerata*	0-3	2	30
LOPE	*Lolium perenne*	0-2	1	30
Noxious Weeds				
BRTE	*Bromus tectorum*	0-3	2	30
Total Graminoid Cover		40-90	75	100

PHYSICAL AND BIOLOGICAL ENVIRONMENT

Distribution/Setting:

This plant association was found in the Central Franciscan Subsection, in the northern portion of the Northern California Coast Ranges Section of the National Hierarchy. Plots were located on the Lower Trinity Ranger District of the Six Rivers National Forest. Mean distance to the Pacific Ocean was 27.9 miles and ranged from 26.8 to 30.2 miles inland.

Elevation averaged 2976 feet, lowest in the *Cynosurus echinatus* alliance. Elevation ranged from 2100 to 3980 feet. Mean annual precipitation averaged 76 inches and was the highest in the series. Slopes were moderately steep, averaging 22% and ranging from 15-35%. Aspects were mainly southwest facing with limited plots that faced southeast. Mean annual radiation index was a relatively warm .517, among the warmest in the series.

Sites were located primarily in the middle 1/3 slope positions with undulating/linear horizontal micro-relief and convex/undulating vertical micro-relief.

Soil Summary:

Soils in this type were thermic (100%), deep (60%) and moderately deep (40%). Soil drainage was well drained and moderately well drained. They formed in colluvium and residuum from sandstone, sedimentary rocks. The litter layer had an average thickness of 0.4 inches at 91% cover. Bare ground averaged 3%, lowest in the *Cynosurus echinatus* series and ranged from (0-10%). Surface rock and gravel averaged 3% cover, also the lowest in the series and ranged from 0-6%. The surface horizon averaged 11 inches thick and ranged from 4-17 inches thick. It had loam, gravelly loam and very gravelly loam textures. Surface colors were 10YR 3/1 (very dark gray), 10YR 3/2 (very dark grayish brown) and 10YR 3/3 (dark brown). Coarse fragment content averaged 22% and ranged from 7-36%. Clay content averaged 21% and ranged from 16-26%. Soil pH averaged 6.1, slightly acid and ranged from 5.5-7.0.

The subsoils had gravelly loam, clay loam, very cobbly clay loam and very cobbly sandy loam textures. Subsoil colors were 10YR 3/1 (very dark gray), 10YR 3/2 (very dark grayish brown), 10YR 4/3 (dark brown) and 2.5Y (very dark grayish brown). Subsoil coarse fragment content averaged 29% and ranged from 5% to 62%. Subsurface clay content averaged 28% and ranged from 24% to 37%. Subsurface pH averaged 6.7, neutral and ranged from 5.7 to 7.6. The soils were 40% skeletal. Soil AWC averaged 2.5 inches and ranged from 1.8 inches to 3.3 inches. The soils were classified into the subgroups Pachic Xerumbrepts, Dystric Xerochrepts and Typic Xerumbrepts.

Argillic horizons were only found in 40% of these plots. Depth to the argillic horizon varied from 12 to 24 inches and averaged 18 inches. Moisture conditions are further influenced by the moist middle 1/3 slope positions with undulating/linear micro-relief. The result of this was the second highest total vegetation cover and grass cover in the *Cynosurus echinatus* alliance.

Vegetation Summary:
Total vegetation cover was dense (95%) and was dominated by grasses (75%). The tree layer was absent. Poison-oak (*Toxicodendron diversilobum,* 2%) represented the shrub layer in 40% of the sites. Total cover in the forb layer was 41% and included common dandelion (*Taraxacum officinale,* 3%), and small-flowered lotus (*Lotus micranthus*, 12%). The grass layer was dominated by hedgehog-dogtail (*Cynosurus echinatus,* 26%) in frequent association with soft chess (*Bromus hordeaceus,* 21%), silver hairgrass (*Aira caryophyllea,* 5%) common oats (*Avena fatua*, 13%) and ripgut brome (*Bromus diandrus*, 13%).

Species Richness:
Mean species richness was 19.2 species/plot, third lowest in the *Cynosurus echinatus* alliance. Shannon diversity index was 2.1. Native grass species diversity was 0.6 species/plot, lowest in the series. It appears to have been severely affected by non-native grasses competition. For example, 70% of the 10 plots sampled in this type had no native grasses while an additional 20% had only one native grass species present. Non-native grasses dominated the grass layer with an average of 6.2 species/plot, highest in the series. Forb species diversity also appeared to be affected by competition from non-native species. It averaged 5.9 native species/plot, lowest in the series, and 6.0 non-native species/plot, highest in the series.

Ecological Status:
This type had the third highest mean grass cover (75%) in the *Cynosurus echinatus* alliance. Grass cover was split between annual species (70%) and perennial species (6%). All of the annual grass cover was made up of non-native species (70%); in fact no native annual grasses were identified in this type. Perennial grass cover was primarily native species (5%), with one of the plots containing > 30% native perennial cover.

The grass layer seral status (long-term) points toward the dominance of cover in early seral species (71%), with low cover in mid-seral species (4%) and late seral species (< 1%). Only twenty-three percent of these plots had > 10% cover of mid and late seral species.

In the short-term (1-5 years) the overall species composition is dramatically improved as indicated by the relatively high cover (39%) of low disturbance related tall annual grasses. This is likely related to reduced disturbance by cattle grazing as stocking rates have declined. Historical impacts of cattle grazing appear to have been higher as indicated by < 1% cover of late seral species. This is further supported by the fact that cover of high disturbace species (6%) is much below the presence of early seral plants (71%). This indicates that increased management efforts here could lead to an improvement in short-term and eventually long-term ecological status.

Forb cover was the third highest in the *Cynosurus echinatus* alliance (41%). It was split between annual species (26%) and perennial species (15%). Perennial forb cover was the third highest in the alliance. This differed substantially from the

grass layer with 14% of the annual forb cover and 4% of the perennial forb cover being made up of native species. Thirty percent of the plots had > 20% cover of native forbs and ten percent had > 40% cover of native forbs.

The long-term seral status of forb species shows an unbalanced composition of seral stages. It included 35% mean cover of early seral species, 5% mean cover of mid seral and 1% late seral species. There were no examples of late seral forb cover to mimic and only two plots had > 10% cover of mid seral forbs.

Management Emphasis Rating:
The management emphasis rating for this type was generally low. This was due to low bare ground, high litter cover, very low cover of noxious and invasive exotoc weeds, and high cover of low disturbance indicator species.

Site Potential:
This type contained several native perennial grass species of low constancy and cover. These include *Bromus carinatus*, *Carex* sp., *Danthonia californica, Elymus glaucus, Juncus* spp., *Luzula comosa* and *Achnatherum lemmonii.* These species can be considered as remnants of the past community and should be considered as long-term restoration objectives.

Closely Related Types:
This type was most similar to the *Cynosurus echinatus-Bromus hordeaceus/ Taraxacum officinale* type. They differed in the lower precipitation, more inland site locations, upper 1/3 micro-position, linear horizontal micro-relief, higher bare ground cover, lower radiation index and more northerly position along the Y axis of the latter type.

It was also closely related to the *Arrhenatherum elatius-Cynosurus echinatus/ Dichelostemma capitatum* type, which was found within the same general range of environment parameters. They differ in the cooler aspects and radiation index along with the lower clay content and greater depth to the argillic horizon found on the latter type.

Noxious Weeds:
Thirty percent of the plots contained low cover of the Cal-EPPC List A1 noxious weeds, yellow star-thistle *(Centaurea solstitialis,* 1%) and cheatgrass (*Bromus tectorum,* 2%). St. John's wort (*Hypericum perforatum*) was found at 1% cover in 10% of the plots in this plant community.

MANAGEMENT IMPLICATIONS:

One hundred percent of the plots in this type had soils rated as having a high sensitivity to compaction. It is suggested that grazing readiness dates be reviewed to avoid moving lievestock onto these sites when the soil is too wet to minimize the potential for compaction.

Small infestations of yellow star-thistle and St. John's wort should be completely eradicated, with monitoring in subsequent years to track re-infestation from the seed bank or resprouting of St. John's wort from its roots. New infestations of cheatgrass should likewise be dealt with before it becomes dominant and alters the water holding capacity of the soil surface.

Plant Association: ***Cynosurus echinatus-Bromus hordeaceus-Taeniatherum caput-medusae***
Hedgehog-dogtail-Soft Chess-Medusahead
EDP Code: **CYEC-BRHO2-TACA8**
EcoCode: **GAHDFX05**

Indicator Species:

***Bromus hordeaceus* (Soft Chess):** This non-native, annual grass species was the most extensive grass species found in the Northern Province annual grasslands and should be considered naturalized. It was found on dry, warm, south and east facing, mid-elevation sites throughout the southern portion of the Northern Province.

Cynosurus echinatus-Bromus hordeaceus-Taeniatherum caput-medusae
Hedgehog-dogtail-Soft Chess-Medusahead
CYEC-BRHO2-TACA8 Association, EcoCode: GAHDFX05

Wildlife Habitat Relationships Type: Annual Grassland

SUMMARY TABLE
(Sample size: 24)

Species Richness: 20.6
Shannon Index: 2.2

Environment:
Distance to Ocean: 29-41 miles;
Elevation: 2090-4320 ft.;
Aspect: South, West, outlier Northeast;
Slope: 4-43%;
Slope Position: Upper 1/3, Middle 1/3;
Micro-relief:
  Horizontal: linear/convex;
  Vertical: linear/concave;
Bare ground: 2-30%;
Surface Rock: 1-21%;
Litter Cover: 0-20%, outlier 40%

Ecological Status (Mean % Cover):

	Grasses	Forbs
Ann. Native	0.0	7.8
Ann. Exotic	58.3	4.0
Perenn. Native	9.5	9.2
Perenn. Exotic	0.5	2.3

Seral Status:	R5 Grasses	1-5 Year	R5 Forbs
Early	56.1	13.0	13.9
Mid	6.1	0.1	7.1
Late	2.0	19.2	1.3

Soils:
Pit Depth: 40+ in.;
AWC: 1.7-2.9 in.;
Parent Material: Sandstone, Argillite;
A Horizon:
  Coarse Fragments: 1-21%;
  Textures: gcl;
  Clay content: 20-24%;
  Thickness: 5-12 in.;
Surface pH: 5.7-6.3;
Depth to Argillic Horizon: 15 inches

		% COVER RANGE	MEAN	CON
Tree Overstory Layer				
PIPO	*Pinus ponderosa*	0-5	5	4
QUGA2	*Quercus garryana*	0-5	5	4
Tree Understory Layer				
PIPO	*Pinus ponderosa*	0-1	1	4
PSME	*Pseudotsuga menziesii*	0-1	1	4
Shrubs				
None				
Forbs				
MADIA	*Madia* sp.	0-15	3	63
TOAR	*Torilis arvensis*	0-10	3	58
GAPA5	*Galium parisiense*	0-1	1	54
DICAC5	*Dichelostemma capitatum* ssp.*c.*	0-1	1	50
TRMI4	*Trifolium microcephalum*	0-3	1	46
RUAC	*Rumex acetosella*	0-15	3	42
CLARK	*Clarkia* sp.	0-5	1	42
TRLO	*Trifolium longipes*	0-5	1	38
WYLO	*Wyethia longicaulis*	0-15	5	33
AGHE2	*Agoseris heterophylla*	0-5	3	33
TRLA16	*Tritelia laxa*	0-5	2	33
CEGL2	*Cerastium glomeratum*	0-1	1	33
PLNO	*Plagiobothrys nothofulvus*	0-1	1	33
TRWI3	*Trifolium wildenovii*	0-1	1	33
VEAR	*Veronica arvensis*	0-1	1	33
HECOL	*Hemizonia congesta* ssp. *luzulaefolia*	0-30	7	25
ACMI2	*Achillea millefolium*	0-2	1	25
Noxious Weeds				
HYPE	*Hypericum perforatum*	0-2	1	42
CEME2	*Centaurea melitensis*	0-1	1	8
CESO3	*Centaurea solstitialis*	0-10	10	4
Total Forb Cover		20-60	23	100
Graminoids				
CYEC	*Cynosurus echinatus*	10-60	24	100
BRHO2	*Bromus hordeaceus*	0-30	8	96
AICA	*Aira caryophyllea*	0-70	13	67
ELGL	*Elymus glaucus*	0-15	5	54
POA	*Poa* sp.	0-1	1	46
AVFA	*Avena fatua*	0-15	7	42
DACAA	*Danthonia californica* var. *americana*	0-10	4	38
ACLE8	*Achnatherum lemmonii*	0-20	5	33
AVBA	*Avena barbata*	0-10	3	33
BRDI3	*Bromus diandrus*	0-5	2	33
Noxious Weeds				
TACA8	*Taeniatherum caput-medusae*	0-20	9	71
BRTE	*Bromus tectorum*	0-20	5	58
Total Graminoid Cover		40-94	68	100

PHYSICAL AND BIOLOGICAL ENVIRONMENT

Distribution/Setting:

This plant association was found in the Central Franciscan and Eastern Franciscan subsections, in the northern portion of the Northern California Coast Ranges Section of the National Hierarchy. Sites were located on the Mad River Ranger District of the Six Rivers National Forest. Mean distance to the Pacific Ocean was 36.6 miles and ranged from 29.0 to 40.9 miles inland.

Elevation averaged 3185 feet, among the lowest in the *Cynosurus echinatus* alliance. Elevation ranged from 2090 to 4320 feet. Mean annual precipitation averaged 65 inches and fell toward the middle of the series. Slopes were moderately steep, averaging 19% and ranged from 4-43%. Aspects were mainly south and west facing with limited plots that faced northeast. Mean annual radiation index was a relatively cool .486.

Sites were located primarily in the upper and middle 1/3 slope positions with linear/convex horizontal and linear/concave vertical micro-relief.

Soil Summary:

Soils in this type were found in the thermic (100%) temperature regime. Soil depth was deep (100%) with soil drainage class of moderately well and well drained. They formed in residuum and colluvium from sandstone and argillite, sedimentary rocks. The litter layer had an average thickness of 0.3 inches at 9% cover. Bare ground averaged 11% and ranged from (2-30%). Surface rock and gravel averaged 6% cover and ranged from 1-21%. The surface horizon averaged 9 inches thick and ranged from 5-12 inches thick. It had gravelly loam texture. Surface color was 2.5Y 5/3 (light olive brown). Coarse fragment content averaged 21% and ranged from 20-22%. Clay content averaged 22% and ranged from 20-24%. Soil pH averaged 6.0, moderately acid, and ranged from 5.7-6.3.

The subsoils had clay loam and very gravelly clay textures. Surface colors were 2.5Y 3/1 (very dark gray) and 2.5Y 3/2 (very dark grayish brown). Subsoil coarse fragment content averaged 33% and ranged from 10% to 50%. Subsurface clay content averaged 40% and ranged from 38% to 42%. Subsurface pH averaged 6.0, moderately acid and ranged from 5.9 to 6.1. The soils were 50% skeletal. Soil AWC averaged 2.3 inches and ranged from 1.7 inches to 2.9 inches. The soils were classified into the subgroup Typic Argixerolls.

Argillic horizons were found in 100% of the plots. This horizon usually leads to drier conditions that influence grass cover by restriction of rooting depth. In this case, depth to the argillic horizon varied from 12 to 19 inches and averaged 15 inches. Moisture conditions were further influenced by the dry upper 1/3 slope positions, linear/convex micro-relief and high bare ground, resulting in the lowest total vegetation cover and forb cover in the *Cynosurus echinatus* alliance.

Vegetation Summary:

Total vegetation cover was78% and was dominated by grasses (68%). The tree layer was negligible, with 5% cover of Douglas-fir (*Pseudotsuga menziesii*) and Oregon white oak (*Quercus garryana*) in the overstory and 1% cover of both ponderosa pine (*Pinus ponderosa*) and Douglas-fir in the regeneration layer of one plot. The shrub layer was absent. Clovers (*Trifolium* spp.), especially long-stalked (*T. longipes,* 1%), small headed (*T. microcephalum,* 1%), and tomcat (*T. wildenovii,* 1%) clover, dominated the high (123%) cover of the diverse forb layer, often in association with annual tarweeds (*Madia* spp., 3%). Hedgehog-dogtail (*Cynosurus echinatus,* 24%) dominated the grass layer, which generally included soft chess (*Bromus hordeaceus,* 8%), silver hairgrass (*Aira caryophyllea,* 13%) and the noxious weed, medusahead (*Taeniatherum caput-medusae,* 9%).

Species Richness:
Mean species richness was 20.6 species/plot, which fell in the middle of the *Cynosurus echinatus* series. Shannon diversity index was 2.2. Native grass species diversity was 1.7 species/plot, third highest in the series. It appears to have been moderately affected by non-native grass competition. For example, seventeen percent of the 24 plots sampled in this type had no native grasses while 25% had only one native grass species present. Non-native grasses still dominated the grass layer with an average of 6.2 species/plot, highest in the series. Forb species diversity was moderate with an average of 8.7 native species/plot and only 3.6 non-native species/plot.

Ecological Status:
This type had moderate mean grass cover (68%) in comparison to the rest of the *Cynosurus echinatus* alliance. Grass cover was split between annual species (58%) and perennial species (10%). Almost all of the annual grass cover was made up of non-native species (58%), in fact; only two plots had one native annual grass species. Perennial grass cover was primarily native species (10%), with 46% of the plots containing > 10% native perennial cover.

The grass layer seral status (long-term) points toward the dominance of cover in early seral species (56%), with low cover in mid-seral species (6%) and late seral species (2%). Twenty-nine percent of these plots had > 10% cover of mid seral species and only 8% had > 10% cover of late seral species.

In the short-term (1-5 years), the overall species composition is somewhat improved as indicated by the moderate cover (19%) of low-disturbance related tall annual grasses. This is likely related to reduced disturbance by cattle grazing as stocking rates have declined. Historically, impacts of grazing appear to have been higher as indicated by only 2% cover of late seral species, and the fact that cover of high disturbace species (13%) is much below the presence of early seral plants (56%). This indicates that increased management efforts here could lead to an improvement in short-term and eventually long-term ecological status.

Forb cover in thie association was the lowest in the *Cynosurus echinatus* alliance (23%). It was split between annual species (12%) and perennial species (12%). Eight percent of the annual forb cover and 9% of the perennial forb cover was made up of native species. Twenty-nine percent of the plots had > 20% cover of native forbs and 8% had > 40% cover of native forbs

The long-term seral status of forb species also shows an unbalanced composition of seral stages. It included 14% mean forb cover of early seral species, 7% mean cover of mid seral and 1% late seral species. There were seven examples of mid seral forb cover to mimic with seven plots having > 10% cover of mid seral forbs. There were no examples of late seral forb cover to mimic.

Managernent Emphasis Rating:
The management emphasis rating for this type was generally high. This was due to the high bare ground cover, high cover of noxious and invasive weeds and occassional high cover of high disturbance grass species.

Site Potential:
This type contains a host of native perennial grass species of low to moderate constancy and low cover. These include *Bromus carinatus, Danthonia californica, Deschampsia elongata, Elymus glaucus, Elymus multisetus, Festuca californica, Festuca idahoensis, Juncus bufonius, Juncus confusus, Luzula comosa, Melica* sp. and *Achnatherum lemmonii.* These species can be considered as remnants of the past community and should be considered as long-term restoration objectives.

Closely Related Types:
This type appears to be a degraded representation of the *Cynosurus echinatus-Bromus hordeaceus-Avena fatua* type.

Noxious Weeds:
This plant association contained moderate cover of the Cal EPPC List A1 noxious weeds, medusahead (*Taeniatherum caput-medusae*, 9%) and cheatgrass (*Bromus tectorum*, 5%) on 71% of the sites, as well as high cover of yellow star-thistle (*Centaurea solstitialis*, 10%) in 4% of the plots, and low cover of St. John's wort (*Hypericum perforatum*, 1%) in 42% of the plots.

MANAGEMENT IMPLICATIONS:

Fifty-eight percent of the plots in this type had 10-30% bare ground. Management actions here should be aimed at recovery of the high bare ground areas (> 20%) and prevention of the moderate bare gound (10-20%) areas form increasing. The high bare ground areas will require recovery time, while the moderate areas would benefit from increased litter cover in order to prevent exceeding Region 5 soil erosion standards.

Forty-six percent of the plots in this type had > 10% cover of noxious and invasive weeds. Frequently this high cover was made up of the noxious weeds, *Taeniatherum caput-medusae*, *Bromus tectorum, Centaurea solstitialis* and *Hypericum perforatum*. The variable cover of weeds over the plots indicates that weed density is likely increasing, especially for *Taeniatherum caput-medusae* and *Centaurea solstitialis*. The moderate litter cover indicates that grazing intensity is not excessive. Lack of high cover of palatable grass species and dominance by the undesirable grass *Cynosurus echinatus* is a primary reason why cattle use of the type is relatively low. Increased management emphasis is necessary here to prevent noxious weed dominance on these sites. Increasing the abundance of *Bromus hordeaceus, Avena barbata* and *Avena fatua* should be an intermediate goal, followed by regeneration and establishment of new native perennial grass seedlings from existing mature plants. Unfortunately, few options exist to arrest the continued invasions by *Taeniatherum caput-medusae* and *Centaurea solstitialis* except for maintaining or increasing cover of annual and perennial grasses. Where manageably-small satellite populations of *Centaurea solstitialis* are present, hand removal of plants prior to seed shatter over several years can be an effective eradication method. However, such management must remove all plants until none are present or reappear.

Recommended treatments against medusahead (*Taeniatherum caput-medusae*) infestations include: controlled burning in late spring when seeds are still immature, "flash" grazing or heavy grazing during spring before seeds heads form, especially in areas previously burned, and restoration using squirreltail (*Elymus elymoides*) or other strong colonizing perennial grasses. Successful eradication of large infestations of medusahead has not been demonstrated. It is imperative that small populations be controlled before they explode.

Large infestations of cheatgrass *(Bromus tectorum)* are best addressed by subjecting the population to a combination of treatments to keep it under constant stress, each treatment reinforcing the others. These include: 1) prescribed burning in summer/fall to destroy the seed crop; 2) carefully timed grazing; 3) reseeding with native perennials to provide competition; and 4) herbicides. There are no known biological controls.

Bio-controls, including foliage and root-boring beetles have historically been successful in California in controlling St. John's wort. The aim is to eliminate new seed production and deplete the existing seedbank, and then develop management practices that deter reinfestation. Any eradication program should be expected to be long term, as noxious weeds have a large seedbank that will allow the population to reestablish itself for several years.

Plant Association: ***Cynosurus echinatus-Bromus hordeaceus-Bromus tectorum***
Hedgehog-Dogtail-Soft Chess-Cheatgrass
EDP Code: **CYEC-BRHO2-BRTE**
EcoCode: **GAHDFX06**

Indicator species:

***Bromus tectorum* (Cheatgrass):** Cheatgrass is a non-native annual grass and an ubiquitous component of annual grasslands and oak woodlands in Northern California. It is notorious for alteration of fire cycles due to its dominance in rangelands and its high flammability. It is a winter annual that germinates and establishes root systems at lower temperatures than perennial grasses are able to. Cheatgrass is extremely tenacious and can provide such intense competition to other newly emerging seedling that few native plants are able to become established. An abundance of cheatgrass indicates range deterioration.

Cynosurus echinatus-Bromus hordeaceus-Bromus tectorum
Hedgehog-Dogtail-Soft Chess-Cheatgrass
CYEC-BRHO2-BRTE Association, EcoCode: GAHDFX06
Wildlife Habitat Relationships Type: Annual Grassland

SUMMARY TABLE
(Sample size: 8)

Species Richness: 16.8
Shannon Index: 2.1

Environment
Distance to Ocean: 36-43 miles;
Elevation: 2720-4480 ft.;
Aspect: South;
Slope: 15-40%;
Slope Position: Upper 1/3;
Micro-relief:
  Horizontal: linear/convex;
  Vertical: concave/linear;
Bare ground: 8-25%;
Surface Rock: 323%;
Litter Cover: 2-15%

Ecological Status (Mean % Cover):

	Grasses	Forbs
Ann. Native	0.0	10.8
Ann. Exotic	53.0	4.6
Perenn. Native	1.0	4.6
Perenn. Exotic	0.4	5.0

Seral Status:	R5 Grasses	1-5 Year	R5 Forbs
Early	53.4	13.6	20.8
Mid	0.3	1.3	2.9
Late	0.6	15.6	1.0

Soils:
Pit Depth: 25-38 in.;
AWC: 2.5-2.9 in.;
Parent Material: Sandstone;
A Horizon:
  Coarse Fragments: 20-30%;
  Textures: Cl;
  Clay content: 30-40%;
  Thickness: 4-9 in.;
  Surface pH: 6.6-7.0;
Depth to Argillic Horizon: 6 inches

		% COVER RANGE	MEAN	CON
Tree Overstory Layer				
None				
Tree Understory Layer				
None				
Shrubs				
None				
Forbs				
ERBO	*Erodium botrys*	0-5	3	88
LOMI	*Lotus micranthus*	0-10	5	63
MADIA	*Madia* sp.	0-5	3	63
LUBI	*Lupinus bicolor*	0-1	1	63
RUAC	*Rumex acetosella*	0-15	8	50
EPBR3	*Epilobium brachycarpum*	0-2	1	50
TOAR	*Torilis arvensis*	0-5	2	38
ESCA2	*Eschscholzia californica*	0-1	1	38
VEAR	*Veronica arvensis*	0-1	1	38
AMME	*Amsinkia menziesii*	0-5	3	25
ERSE3	*Eremocarpus setigera*	0-5	3	25
MARAH	*Marah* sp.	0-3	2	25
AGHE2	*Agoseris heterophylla*	0-1	1	25
CEGL2	*Cerastium glomeratum*	0-1	1	25
DICAC5	*Dichelostemma capitatum* ssp. *c.*	0-1	1	25
GAPA5	*Galium parisiense*	0-1	1	25
NEMOP	*Nemophila* sp.	0-1	1	25
PLCO4	*Plectritis congesta*	0-1	1	25
PLNO	*Plagiobothrys nothofulvus*	0-1	1	25
TRHY3	*Tritelia hyacanthina*	0-1	1	25
VELA	*Verbena lasiostachys*	0-1	1	25
Noxious Weeds				
HYPE	*Hypericum perforatum*	0-5	3	25
Total Forb Cover		10-40	25	100
Graminoids				
CYEC	*Cynosurus echinatus*	1-65	21	100
BRHO2	*Bromus hordeaceus*	8-20	14	100
AICA	*Aira caryophyllea*	0-15	9	88
ACLE8	*Achnatherum lemmonii*	0-1	1	38
AVFA	*Avena fatua*	0-5	3	25
POA	*Poa* sp.	0-1	1	25
Noxious Weeds				
BRTE	*Bromus tectorum*	0-20	7	88
TACA8	*Taeniatherum caput-medusae*	0-10	8	25
Total Graminoid Cover		30-80	54	100

PHYSICAL AND BIOLOGICAL ENVIRONMENT

Distribution/Setting:

This plant association was found in the Central Franciscan and Eastern Franciscan subsections in the northern portion of the Northern California Coast Ranges Section of the National Hierarchy. Plots were located on the Mad River Ranger District of the Six Rivers National Forest. Mean distance to the Pacific Ocean was 39.6 miles, second highest in the *Cynosurus echinatus* alliance. It ranged from 35.8 to 43.3 miles inland.

Elevation averaged 3784 feet highest in the series and ranged from 2720 to 4480 feet. Mean annual precipitation averaged 64 inches and fell toward the low end of the *Cynosurus echinatus* alliance. Slopes were moderately steep, averaging 23% and ranging from 15-40%. Aspects were mainly south facing with a hot mean annual radiation index of .527, highest in the series.

Sites were located in the upper 1/3 slope position with linear/convex horizontal and concave/linear vertical micro-relief.

Soil Summary:

Soils in this type were found in the thermic (100%) temperature regime. Soil depth was moderately deep (100%) with a soil drainage class of well drained. They formed in residuum from sandstone, sedimentary rocks. The litter layer had an average thickness of 0.2 inches at 6% cover. Bare ground averaged 15%, highest in the *Cynosurus echinatus* alliance and ranged from (8-25%). Surface rock and gravel averaged 11% cover and was also the second highest in the series. It ranged from 3-23% surface cover. The surface horizon averaged 6 inches thick. It had clay loam texture. Surface color was 2.5Y 5/2 (grayish brown). Clay content averaged 35% and ranged from 30-40%. Coarse fragment content averaged 25% and ranged from 20% to 30%. Soil pH averaged 6.8, neutral and ranged from 6.6 to 7.0.

The subsoils had gravelly clay textures. Subsoil color was 2.5Y 6/2 (light brownish gray). Subsoil coarse fragment content averaged 20%. Subsurface clay content averaged 48% highest in the *Cynosurus echinatus* alliance and ranged from 40% to 55%. Subsurface pH averaged 7.0, neutral. The soils were 100% non-skeletal. Soil AWC averaged 2.8 inches and ranged from 2.5 inches to 2.9 inches. The soils were classified into the subgroup Mollic Haploxeralfs.

Argillic horizons were found in all 100% of the plots, with an average depth of 6 inches. This shallow horizon depth usually leads to drier conditions that influence vegetation cover by its restriction of rooting depth. This type was found primarily in dry upper 1/3 slopes with convex and linear micro-relief, moderate slopes, high bare ground, high surface rock and gravel cover. These factors together with the argillic horizons contribute to the lowest total vegetation cover and grass cover in the *Cynosurus echinatus* alliance and second lowest forb cover in the series.

Vegetation Summary:

Total vegetation cover was 77% and was dominated by grasses (54%). Both the tree layer and shrub layer were absent. Total cover in the forb layer was 25% and included long-beaked storksbill (*Erodium botrys*, 4%), generally in association with small-flowered lotus (*Lotus micranthus*, 5%), bicolor lupine (*Lupinus bicolor*, 1%) and tarweeds (*Madia* spp., 3%). Hedgehog-dogtail (*Cynosurus echinatus*, 21%) and soft chess (*Bromus hordeaceus*, 14%) dominated the grass layer, which frequently included silver hairgrass (*Aira caryophyllea*, 9%) and the noxious weed,

cheatgrass (*Bromus tectorum*, 7%).

Species Richness:
Mean species richness was 16.8 species/plot, lowest in the *Cynosurus echinatus* alliance. Shannon diversity index was 2.1. Native grass species diversity was 0.7 species/plot, second lowest in the series. It appears to have been severely affected by non-native grasses competition. For example, fifty percent of the 8 plots sampled in this type had no native grasses while an additional 25% had only one native grass species present. Non-native grasses dominated the grass layer with an average of 5.5 species/plot. Forb species diversity was moderate with an average of 7.2 native species/plot and 3.2 non-native species/plot.

Ecological Status:
This type had moderate mean grass cover (54%) in comparison to the rest of the *Cynosurus echinatus* alliance. Grass cover was split between annual species (53%) and perennial species (1%). All of the annual grass cover was made up of non-native species (53%). Perennial grass cover was primarily native species (1%).

The grass layer seral status (long-term) points toward the dominance of cover in early seral species (53%), with very low cover in mid-seral species (< 1%) and late seral species (< 1%). None of these plots had > 10% cover of mid or late seral species.

In the short-term (1-5 years) the overall species composition is improving as indicated by the moderate cover (16%) of low disturbance related tall annual grasses. This is likely related to reduced disturbance by cattle grazing as stocking rates have declined. Historical impacts of cattle grazing appear to have been higher as indicated by < 1% cover of late seral species. This is further supported by the fact that cover of high disturbace species (14%) is much below the presence of early seral plants (53%). This indicates that increased management efforts here could lead to an improvement in short-term and eventually long-term ecological status.

Forb cover was the second lowest in the *Cynosurus echinatus* alliance (25%). It was split between annual species (15%) and perennial species (10%). This differed substantially from the grass layer with 11% of the annual forb cover and 5% of the perennial forb cover being made up of native species. Thirty-seven percent of the plots had > 20% cover of native forbs.

The long-term seral status of forb species also shows an unbalanced composition of seral stages. It included 21% mean forb cover of early seral species, 3% mean cover of mid seral and 1% late seral species. There were no examples of mid or late seral forb cover to mimic.

Management Emphasis Rating:
The management emphasis rating for this type was generally high. This was due to high bare ground, high gravel and rock, low litter cover, occasional high cover of noxious and invasive exotoc weeds, and short-term cover of high disturbance indicator species. Further analysis at the plot level could identify opportunities for treatment of localized weed infestations to check their spread.

Site Potential:
This type contained several native perennial and annual grass species of low constancy and cover. They included *Bromus carinatus*, *Danthonia californica*,

Hordeum brachyantherum, Juncus spp. and *Achnatherum lemmonii.* These species can be considered as remnants of the past community and should be considered as long-term restoration objectives.

Closely Related Types:
This type is closely related to the *Bromus hordeaceus-Bromus tectorum* type. They differ in the more inland location, steeper slopes, and tendency toward middle 1/3 slope positions, linear/convex vertical micro-relief and higher bare ground cover of the latter type.

Noxious Weeds:
Moderate cover was noted of the CalEPPC List A1 noxious weeds, cheatgrass (*Bromus tectorum*, 6%) on 100% of the plots, and medusahead (*Taeniatherum caput-medusae*, 8%) on 25% of the plots. Low cover of St. John's wort (*Hypericum perforatum*, 3%) was found in 20% of the plots in this plant community.

MANAGEMENT IMPLICATIONS:

Twenty-five percent of the plots in this type had $\geq$ 20% bare ground and an additional fifty percent have moderate (10-20%) bare ground. The areas with high bare ground will require recovery time, while areas with moderate bare ground will benefit from increased litter cover in order to prevent exceeding Region 5 soil erosion standards.

Fifty percent of the plots in this type had soils rated as having a high sensitivity to compaction.

All of the plots in this type contain noxious weeds. Fortunately, their cover is still relatively low and could likely be managed if sufficient management emphasis is applied.

Large infestations of cheatgrass *(Bromus tectorum)* are best addressed by subjecting the population to a combination of treatments to keep it under constant stress, each treatment reinforcing the others. These include: 1) prescribed burning in summer/fall to destroy the seed crop; 2) carefully timed grazing; 3) reseeding with native perennials to provide competition; and 4) herbicides. There are no known biological controls.

To reduce large infestations of yellow star-thistle *(Centaurea solstitialis)*, several controls have been utilized by land managers with varying success, the best success achieved when methods are used in combination. All are long-term endeavors that must be maintained over time. These include: 1) biological control by means of the hairy weevil and/or seedhead fly; 2) controlled grazing by cattle or sheep timed to specific stages of yellow star-thistle development; 3) mowing timed to specific stages of yellow star-thistle development and repeated at least once per season; 4) prescribed burning in late spring timed to specific stage of yellow star-thistle development; and 5) herbicides.

Bio-controls, including foliage and root-boring beetles have historically been successful in California in controlling St. John's wort (*Hypericum perforatum).*

The aim is to eliminate new seed production and deplete the existing seedbank, and then develop management practices that deter re-infestation. Any eradication program should be expected to be long term, as noxious weeds have a large seedbank that will allow the population to reestablish itself for several years.

ANNUAL GRASSLAND SERIES SPECIES LIST

Species	Common Name	EDP Code	Annual/ Perenn.	Native/ NonNative
TREES				
Juniperus occidentalis	western juniper	JUOC		N
Pinus ponderosa	ponderosa pine	PIPO		N
Pseudotsuga menziesii	Douglas-fir	PSME		N
Quercus garryana	Oregon white oak	QUGA4		N
SHRUBS				
Arctostaphylos patula	greenleaf manzanita	ARPA6		N
Ceanothus cuneatus	buckbrush	CECU		N
Holodiscus discolor	oceanspray	HODI		N
Ribes sp.	current, gooseberry	RIBES		N
Rubus sp.	blackberry, raspberry	RUBUS		N/NN
Symphoricarpus mollis	creeping snowberry	SYMO		N
Toxicodendron (Rhus) diversilobum	poison-oak	TODI (RHDI)		N
FORBS				
Achillea millefolium (A. lanulosa)	common yarrow	ACMI2 (ACMI)	P	N
Achlys triphylla	vanilla leaf	ACTR	P	N
Achyrachaena mollis	blow-wives	ACMO2	A	N
Agoseris grandiflora	large-flower agoseris	AGGR	P	N
Agoseris heterophylla	annual agoseris	AGHE2	A	N
Agoseris retrorsa	spearleaf agoseris	AGRE	P	N
Allium sp.	onion	ALLIU	P	N/NN

Species	Common Name	EDP Code	Annual/ Perenn.	Native/ NonNative
Amsinkia sp.	fiddleneck	AMSIN	A	N
Amsinkia intermedia	rancher's fireweed	AMIN3	A	N
Amsinkia menziesii	Menzies' fiddleneck	AMME	A	N
Anagallis arvensis	poor man's weatherglass	ANAR	A	NN
Angelica sp.	angelica	ANGEL	P	N
Arenaria sp.	sandwort	ARENA	A/P	N/NN
Arnica mollis	cordilleran arnica	ARMO4	P	N
Aster sp.	aster	ASTER	A/P	N
Athysanus pusillus	dwarf athysanus	ATPU	A	N
Brodiaea elegans	harvest brodiaea	BREL	P	N
Calochortus superbus	yellow mariposa lily	CASU3	P	N
Calochortus tolmiei	Tolmie's star tulip	CATO	P	N
Calystegia sp.	morning glory	CALYS	P	N
Calystegia occidentalis ssp. *occidentalis*	Modoc morning glory	CAOCO	P	N
Camissonia graciliforа	Hill suncup	CAGR14	A	N
Capsella bursa-pastoris	shepherd's purse	CABU2	A	NN
Cardamine oligosperma	western bittercress	CAOL	A/B	N
Carduus sp.	plumeless thistle	CARDU	A/P	NN
Castilleja sp.	Indian paintbrush	CASTI2	A/P	N
Castilleja attenuata (Orthocarpus a.)	valley tassels	CAAT25 (ORAT)	A	N
Castilleja campestris ssp. *campestris (O. c.)*	field owl's clover	CACAC14 (ORCA3)	A	N
Castilleja miniata ssp. *miniata*	great red Indian paintbrush	CAMIM5	P	N
Castilleja rubicundula ssp. *lithospermoides*	cream sacs	CARUL	A	N
Castilleja tenuis (Orthocarpus hispidus)	hairy orthocarpus	CATE26 (ORHI)	A	N
Centaurea melitensis	tocalote	CEME2	A	NN (*)

Species	Common Name	EDP Code	Annual/ Perenn.	Native/ NonNative
Centaurea solstitialis	yellow starthistle	CESO3	A	NN (*)
Centaurium tricanthum	alkali centaury	CETR2	A	N
Cirsium vulgare	bull thistle	CIVU	B	NN (*)
Cerastium arvense	field chickweed	CEAR4	P	N
Cerastium glomeratum	mouse-ear chickweed	CEGL2	A	N
Chaenactis sp.	pincushion	CHAEN	A/P	N
Chlorogalum pomeridianum	soap root	CHPO3	P	N
Cirsium sp.	thistle	CIRSI	A/P	N/NN
Clarkia sp.	clarkia	CLARK	A	N
Clarkia amoena	herald of summer	CLAM	A	N
Clarkia gracilis	slender clarkia	CLGR	A	N
Clarkia gracilis ssp. *sonomensis*	graceful clarkia	CLGRS	A	N
Clarkia modesta	modest clarkia	CLMO	A	N
Clarkia purpurea ssp. *quadrivulnera*	four spot	CLPUQ	A	N
Claytonia perfoliata (Montia p.)	miner's lettuce	CLPE (MOPE)	A	N
Collinsia sparsiflora	few-flowered blue-eyed Mary	COSP	A	N
Collomia sp.	collomia	COLLO	A/P	N
Convolvulus arvensis	field bindweed	COAR4	P	NN (*)
Cryptantha sp.	cryptantha	CRYPT	A/B/P	N
Cryptantha intermedia	common cryptantha	CRIN8	A	N
Cuscuta californica var. *californica*	California dodder	CUCAC	A	N
Cynoglossum grande	pacific houndstongue	CYGR	P	N
Daucus pusillus	rattlesnake weed	DAPU3	A	N
Delphinium sp.	delphinium/larkspur	DELPH	P	N
Delphinium decorum ssp. *tracyi*	Tracy's larkspur	DEDET	P	N

Species	Common Name	EDP Code	Annual/ Perenn.	Native/ NonNative
Dianthus armeria ssp. *armeria*	grass pink	DIAR	A/B	NN
Dichelostemma capitatum ssp. *c.* (*D. pulchella*)	blue dicks	DICAC5 (DIPU2)	P	N
Dichelostemma multiflorum (*D. parviflorum*)	wild hyacinth	DIMU5 (DIPA4)	P	N
Dichelostemma volubile	snakelily	DIVO	P	N
Dodecatheon sp.	shootingstar	DODEC	P	N
Dodecatheon hendersonii	Henderson's shootingstar	DOHE	P	N
Draba verna	whitlow grass	DRVE2	A	N
Dryopsteris filix-max	male fern	DRFI2	P	N (L2)
Epilobium sp.	fireweed	EPILO	A/P	N
Epilobium brachycarpum (*E. paniculatum*)	annual fireweed	EPBR3 (EPPA)	A	N
Epilobium minutum	smallflower willowherb	EPMI	A	N
Equisetum arvense	common horsetail	EQAR	P	N
Equisetum laevigatum	Braun's scouring-rush	EQLA	P	N
Eremocarpus setigera	turkeymullein	ERSE3	A	
Eriogonum sp.	buckwheat	ERIOG	A/P	N
Eriophyllum lanatum	common wooly sunflower	ERLA6	P	N
Erodium botrys	long-beak storksbill	ERBO	A	NN
Erodium cicutarium	red-stem filaree	ERCI6	A	NN
Erysimum sp.	wallflower	ERYSI	A/B/P	N
Eschscholzia californica	California poppy	ESCA2	A	N
Euphorbia sp.	spurge	EUPHO	A/P	N/NN
Filago gallica	cottonrose	FIGA	A	NN
Galium sp.	bedstraw	GALIU	A/P	N/NN
Galium aparine	goose grass, sticky willy	GAAP2	A	N
Galium parisiense	wall bedstraw	GAPA5	A	NN

Species	Common Name	EDP Code	Annual/ Perenn.	Native/ NonNative
Geranium sp.	geranium	GERAN	A/P	N/NN
Geranium dissectum	cutleaf geranium	GEDI	A	NN
Geranium molle	dovesfoot geranium	GEMO	A	NN
Gilia capillaris	smoothleaf gilia	GICA4	A	N
Gilia tricolor	birds-eye gilia	GITR2	A	N
Githopsis diffusa ssp. *robusta*	San Gabriel bluecup	GIDIR	A	N
Githopsis specularioides	common bluecup	GISP3	A	N
Gnaphalium sp.	cudweed, everlasting	GNAPH	A/B/P	N/NN
Grindelia camporum	great valley resinweed	GRCA	P	N
Hackelia californica	California stickseed	HACA	P	N
Hemizonia congesta ssp. *luzulaefolia*	hayfield tarweed	HECOL3	A	N
Hesperolinon micranthum	dwarf flax	HEMI9	A	N
Hydrophyllum sp.	waterleaf	HYDRO4	P	N
Hypericum perforatum	klamath weed	HYPE	P	NN (*)
Hypochaeris glabra	smooth cat's ear	HYGL2	A	NN
Hypochaeris radicata	false dandelion	HYRA3	P	NN
Iris macrosiphon	slender-tube iris	IRMA	P	N
Lactuca saligna	willow lettuce	LASA	A	NN
Lactuca serriola	prickly lettuce	LASE	A	NN
Lagophylla sp.	hareleaf	LAGOP	A	N
Lasthenia californica (L. chrystoma)	common goldfields	LACA7 (LACH)	A	N
Layia chrysanthemoides	tidytips	LACH	A	N
Lepidium nitidum	shining peppergrass	LENI	A	N
Ligusticum sp.	licoriceroot	LIGUS	P	N
Limnanthes douglasii	Douglas' meadow foam	LIDO2	A	N

Species	EDP Common Name	Annual/ Code	Native/ Perenn.	NonNative
Linanthus sp.	linanthus	LINAN2	A/P	N
Linanthus acicularis	bristly linanthus	LIAC3	A	N (L4)
Linanthus bicolor	bicolored linanthus	LIBI	A	N
Linanthus bolanderi	Bolander's linanthus	LIBO2	A	N
Linanthus ciliatus	whisker brush	LICI	A	N
Linanthus parviflorus (L. androsaceus ssp. *croceus)*	common linanthus	LIPA12 (LIANC)	A	N
Linum bienne (L. angustifolium)	narrowleaf flax	LIBI5 (LIAN3)	P	NN
Lithophragma sp.	woodland star	LITHO	P	N
Lithospermum californicum	California stoneseed	LICA11	P	N
Lomatium sp.	desertparsley	LOMAT	P	N
Lomatium dissectum	fernleaf lomatium	LODI	P	N
Lomatium caruifolium v. *denticulatum (L. humile)*	alkali desertparsley	LOCA5 (LOHU1)	P	N
Lotus sp.	lotus	LOTUS	A/P	N/NN
Lotus corniculatus	birdsfoot deervetch	LOCO	P	NN
Lotus denticulatus	riverbar birdsfoot trefoil	LODE	A	N
Lotus humistratus	shortpod lotus	LOHU2	A	N
Lotus micranthus	small-flower lotus	LOMI	A	N
Lupinus sp.	lupine	LUPIN	A/P	N/NN
Lupinus bicolor	minature lupine	LUBI	A	N
Lupinus croceus	Mount Eddy lupine	LUCR	P	N
Lupinus nanus	sky lupine	LUNA	A	N
Madia sp.	tarweed	MADIA	A/P	N
Madia bolanderi	Bolander's tarweed	MABO	A	N
Madia elegans	common madia	MAEL	A	N
Madia madioides	woodland tarweed	MAMA	A	N

Species	Common Name	EDP Code	Annual/ Perenn.	Native/ NonNative
Madia minima	dwarf madia	MAMI	A	N
Marah sp.	wild cucumber	MARAH	P	N
Marah oreganus	coast man-root	MAOR3	P	N
Marrubium vulgare	horehound	MAVU	P	NN
Medicago polymorpha (M. hispida)	California burclover	MEPO3 (MEHI)	A	NN
Mentha arvensis	field mint	MEAR4	P	N?
Mentha pulegium	pennyroyal	MEPU	P	NN (*)
Micropus californicus var. *californicus*	slender cottonweed	MICAC2	A	N
Mimulus sp.	monkeyflower	MIMUL	A/P	N
Mimulus angustatus	narrowleaf pansy monkeyflower	MIAN2	A	N
Mimulus alsinoides	chickweed monkeyflower	MIAL3	A	N
Mimulus guttatus	seep-spring monkeyflower	MIGU	A/P	N
Monardella odoratisima	mountain pennyroyal	MOOD	P	N
Montia linearis	linearleaf montia	MOLI4	A	N
Navarretia sp.	pincushion plant	NAVAR	A	N
Navarretia intertexta	needleleaf navarretia	NAIN2	A	N
Navarretia pubescens	downy pincushion	NAPU2	A	N
Nemophila sp.	nemophila	NEMOP	A	N
Nemophila pedunculata	meadow nemophila	NEPE	A	N
Pectocarya pusilla	little combseed	PEPU	A	N
Pentagramma (Pityrogramma) triangularis ssp. *t.*	goldenback fern	PETR7 (PITRT)	P	N
Penstemon sp.	beardtongue	PENST	P	N
Perideridia sp.	yampah	PERID	P	N
Perideridia kelloggii	Kellogg's yampah	PEKE	P	N
Phacelia sp.	phacelia	PHACE	A/P	N

Species	Common Name	EDP Code	Annual/ Perenn.	Native/ NonNative
Phlox sp.	phlox	PHLOX	A/P	N
Phlox gracilis (Microsteris g.)	slender phlox	PHGR16 (MIGR1)	A	N
Marah sp.	wild cucumber	MARAH	P	N
Plagiobothrys sp.	popcorn flower	PLAGI	A/P	N
Plagiobothrys nothofulvus	rusty popcorn flower	PLNO	P	N
Plantago erecta	dotseed plantain	PLER3	A	N
Plantago lanceolata	English plantain	PLLA	P	NN
Platystemon californicus	cream cups	PLCA5	A	N
Plectritus brachystemon (P. congesta ssp. *b.)*	pink plectritus	PLBR6 (PLCOB)	A	N
Plectritis congesta	sea blush	PLCO4	A	N
Polystichum munitum	sword fern	POMU	P	N
Prunella vulgaris var. *lanceolata*	mountain self-heal	PRVUL2	P	N
Pteridium aquilinum var. *pubescens*	hairy bracken fern	PTAQP	P	N
Ranunculus sp.	buttercup	RANUN	A/P	N/NN
Ranunculus occidentalis	western buttercup	RAOC	P	N
Rumex acetosella	common sheep sorrel	RUAC	P	NN
Rumex crispus	curlydock	RUCR	P	NN
Sanicula sp.	sanicle	SANIC	B/P	N
Sanicula bipinnata	poison sanicle	SABI2	P	N
Sanicula bipinnatifida	purple sanicle	SABI3	P	N
Sanicula crassicaulis	gembleweed	SACR2	P	N
Sanicula tuberosa	turkeypea	SATU	P	N
Saponaria officinalis	bouncing bet, soapwort	SAOF	P	NN
Sherardia arvensis	blue fieldmadder	SHAR2	A	NN
Sidalcea diploscypha	fringed checkerbloom	SIDI	A	N

Species	Common Name	EDP Code	Annual/ Perenn.	Native/ NonNative
Sidalcea hartwegii	valley checkerbloom	SIHA	A	N
Sidalcea malvaeflora	mallowleaf checkerbloom	SIMA2	P	N
Silene sp.	catchfly	SILEN	A/B/P	N/NN
Silene noctiflora	night-flowering catchfly	SINO	A	NN
Solidago sp.	goldenrod	SOLID	P	N
Soliva sessilis	field burweed	SOSE2	A	NN
Sonchus oleraceus	common sowthistle	SOOL	A	NN
Spergularia sp.	sand spurrey	SPERG2	A	NN
Stachys sp.	hedgenettle	STACH	A/P	N
Stellaria sp.	starwort	STELL	A/P	N/NN
Taraxacum officinale	common dandelion	TAOF	P	NN
Thysanocarpus curvipes	hairy fringepod	THCU	A	N
Torilis arvensis (T. japonica)	European hedgeparsley	TOAR (TOJA)	A	NN
Torilis nodosa	knotted hedgeparsley	TONO	A	NN
Trichostema lanceolatum	vinegar weed	TRLA4	A	N
Trichostema laxum	turpentine weed	TRLA5	A	N
Trifolium sp.	clover	TRIFO	A/P	N/NN
Trifolium albopurpureum var. *dichotoma*	rancheria clover	TRAL5	A	N
Trifolium bifidum var. *bifidum*	notched-leaf clover	TRBIB	A	N
Trifolium ciliolatum	tree clover	TRCI	A	N
Trifolium dubium	shamrock clover	TRDU2	A	NN
Trifolium fucatum	bull clover	TRFU	A	N
Trifolium glomeratum	cluster clover	TRGL4	A	NN
Trifolium longpipes	long-stalked clover	TRLO	P	N
Trifolium macrei	double-headed clover	TRMA2	A	N

Species	Common Name	EDP Code	Annual/ Perenn.	Native/ NonNative
Trifolium microcephalum	small-headed clover	TRMI4	A	N
Trifolium microdon	valpariso clover	TRMI5	A	N
Trifolium variegatum	white-tipped clover	TRVA	A/P	N
Trifolium wildenovii (T. tridentatum)	tomcat clover	TRWI3 (TRTR2)	A	N
Trifolium wormskoldii	cows clover	TRWO	P	N
Tritelia hyacinthina	white brodiaea	TRHY3	P	N
Tritelia laxa	Ithuriel's spear	TRLA16	P	N
Uropappus lindleyi (Microseris l.)	silver puffs	URLI5 (MILI2)	A	N
Verbena lasiostachys	western verbena	VELA	P	N
Veronica arvensis	common brooklime	VEAR	A	NN
Vicia sp.	vetch	VICIA	A/P	N/NN
Vicia americana var. *americana*	American vetch	VIAMA3	P	N
Viola douglasii	golden violet	VIDO	P	N
Vitis californica	wild grape	VICA5	P	N
Wyethia angustifolia	narrow-leaf mule-ears	WYAN	P	N
Wyethia longicaulis	Humboldt mule-ears	WYLO	P	N
Yabea microcarpa (Caucalis m.)	California hedgeparsley	YAMI (CAMI6)	A	N
Zigadenus sp.	deathcamas	ZIGAD	P	N
Zigadenus micranthus var. *macranthus*	smallflower zigadenus	ZIMI2	P	N
Zigadenus venenosus var. *venenosus*	deathcamas	ZIVEV	P	N
GRASSES AND GRASSLIKE				
Achnatherum lemmonii (Stipa l.)	Lemmon's stipa	ACLE8 (STLE1)	P	N
Agrostis microphylla	small-leaf bentgrass	AGMI3	A	N
Aira caryophyllea	European silver hairgrass	AICA	A	NN

Species	Common Name	EDP Code	Annual/ Perenn.	Native/ NonNative
Arrhenatherum eliatus	tall oatgrass	AREL3	P	NN
Avena barbata	slender wild oat	AVBA	A	NN
Avena fatua	wild oats	AVFA	A	NN
Briza minor	little quaking grass	BRMI2	A	NN
Bromus sp.	brome	BROMU	A/P	N/NN
Bromus carinatus var. *carinatus*	California brome	BRCA5	P	N
Bromus diandrus (B. rigidus)	California ripgut grass	BRDI3 (BRRI2)	A	NN
Bromus hordeaceus (B. mollis)	soft chess	BRHO2 (BRMO2)	A	NN
Bromus japonicus	Japanese brome	BRJA	A	NN
Bromus laevipes	woodland bromegrass	BRLA3	P	N
Bromus madritensis ssp. *rubens (B. rubens)*	foxtail chess	BRMAR (BRRU)	A	NN (*)
Bromus sterilis	sterile brome	BRST2	A	NN
Bromus tectorum	cheatgrass	BRTE	A	NN (*)
Carex sp.	sedge	CAREX	P	N
Carex densa	dense sedge	CADE3	P	N
Carex praegracilis	clustered field sedge	CAPR5	P	N
Cynosurus echinatus	hedgehog-dogtail	CYEC	A	NN
Danthonia californica var. *americana*	California oatgrass	DACAA	P	N
Deschampsia danthonioides	annual hairgrass	DEDA	A	N
Deschampsia elongata	slender hairgrass	DEEL	P	N
Eleocharis acicularis var. *acicularis*	needle spikerush	ELAC	P	N
Elymus glaucus ssp. *glaucus*	blue wildrye	ELGLG	P	N
Elymus elymoides (Sitanion hystrix)	squirreltail	ELEL (SIHY)	P	N
Festuca californica	California fescue	FECA	P	N
Festuca occidentalis	western fescue	FEOC	P	N

Species	Common Name	EDP Code	Annual/ Perenn.	Native/ NonNative
Gastridium ventricosum	nit grass	GAVE3	A	NN
Holcus lanatus	velvet grass	HOLA	P	NN
Hordeum brachyantherum	meadow barley	HOBR2	P	N
Hordeum jubatum	foxtail barley	HOJU	A/P	N
Hordeum marinum ssp. *gussoneanum (H. geniculatum)*	mediterranean barley	HOMAG (HOGE)	A	NN
Juncus sp.	wiregrass, rush	JUNCU	A/P	N
Juncus bufonius	common toad-rush	JUBU	A	N
Juncus confusus	Colorado rush	JUCO2	P	N
Juncus effusus	bog rush	JUEF	P	N
Juncus mexicanus	Mexican rush	JUME4	P	N
Juncus nevadensis	Nevada sedge	JUNE	P	N
Juncus patens	spreading rush	JUPA2	P	N
Koeleria macrantha (K. nitida)	junegrass	KOMA (KONI)	P	N
Leymus triticoides	beardless wildrye	LETR3	P	N
Lolium perenne	perennial ryegrass	LOPE	P	NN
Luzula comosa	common woodrush	LUCO6	P	N
Melica sp.	oniongrass	MELIC	P	N
Melica aristata	bearded melicgrass	MEAR	P	N
Nasella pulchra (Stipa p.)	purple needlegrass	NAPU4 (STPU)	P	N
Phalaris aquatica	harding grass	PHAQ	P	NN
Poa sp.	bluegrass	POA	A/P	N/NN
Poa annua	annual bluegrass	POAN	A	NN
Poa palustris	fowl bluegrass	POPA2	P	NN
Poa pratensis ssp. *pratensis*	Kentucky bluegrass	POPR	P	NN
Poa secunda ssp. *secunda (P. sandbergii)*	Sandberg bluegrass	POSES (POSA3)	P	N

Species	Common Name	EDP Code	Annual/ Perenn.	Native/ NonNative
Poa trivialis	rough bluegrass	POTR2	P	NN
Polypogon monspeliensis	rabbitsfoot grass	POMO5	A	NN
Taeniatherum caput-medusae (Elymus c-m)	medusahead	TACA8 (ELCA1)	A	NN (*)
Ventenata dubia	North Africa grass	VEDU	A	NN
Vulpia bromoides (Festuca dertonensis)	six-weeks fescue	VUBR	A	NN
Vulpia microstachys var. *pauciflora*	Pacific fescue	VUMIP	A	N
Vulpia myuros (Festuca megalura)	rat-tail fescue	VUMY	A	NN

A=annual, B=biennial, P=perennial, N=native, NN=non-native, (*)=noxious weed, (L2/L4)=CNPS List 2 or List 4 rare species.

Species in parentheses are scientific names used prior to publication of The Jepson Manual. EDP codes in parentheses are Electronic Data Codes as developed by the USDA Soil Conservation Service prior to 1995.

PLANT ASSOCIATION :	AREL3-CYEC /DICAC5 n=19	PHAQ-BRHO2 /CESO3 n=7	BRHO2-TACA8 /ERBO n=18	BRHO2-AICA /ERODI n=9	BRHO2 /LIDO-TRIFO n=17
TOTAL % COVER	98	91	77	79	91
GRASS % COVER	80	67	63	62	60
FORB % COVER	29	24	31	42	53
SHRUB % COVER	1	3	0	0	0
TREE % COVER	0	0	1	0	0
TREE OVERSTORY:		**% COVER (CONSTANCY)**			
Negligible					
TREE UNDERSTORY:		**% COVER (CONSTANCY)**			
Negligible					
SHRUBS:		**% COVER (CONSTANCY)**			
Ceanothus cuneatus (CECU)	-	3 (71)	-	-	-
FORBS		**% COVER (CONSTANCY)**			
Achillea millefolium (ACMI2)	3 (84)	-	1(11)	-	-
Agoseris sp. (AGOSE)	-	-	2 (61)	-	1 (11)
Amsinkia sp. (AMSIN)	1 (5)	-	1 (6)	-	3 (10)
Brodiaea sp. (BRODI)	6 (11)	-	-	-	3 (6)
Calochortus tolmei (CATO)	1 (21)	2 (29)	-	-	1 (6)
Castilleja attentuata (CAAT25)	1 (5)	1 (14)	-	-	-
Cerastium glomeratum (CEGL2)	1 (32)	1 (43)	3(44)	2 (56)	2 (56)
Centaurea solstitialis (CESO3)	-	14 (100)	28 (11)	6 (44)	-
Chlorogalum pomeridianum (CHPO3)	1 (63)	-	1 (6)	1 (11)	2 (17)
Clarkia sp. (CLARK)	5 (1)	1 (86)	1 (56)	10 (67)	2 (17)
Cynoglossom grande (CYGR)	2 (21)	1 (43)	-	-	-
Dichelostemma capitatum ssp. *c.* (DICAC5)	1 (84)	1 (29)	,1 (56)	1 (78)	1 (33)

PLANT ASSOCIATION :	AREL3-CYEC /DICAC5 n=19	PHAQ-BRHO2 /CESO3 n=7	BRHO2-TACA8 /ERBO n=18	BRHO2-AICA /ERODI n=9	BRHO2 /LIDO-TRIFO n=17
Dichelostemma volubile (DIVO)	-	1 (14)	-	-	-
Draba verna (DRVE2)	-	-	1 (11)	-	1 (30)
Epilobium sp. (EPILO)	-	1 (14)	1 (50)	-	1 (6)
Erodium botrys (ERBO)	-	1 (14)	2 (78)	-	-
Erodium cicutarium (ERCI6)	3 (21)	1 (57)	-	5 (11)	1 (6)
Erodium sp. (ERODI)	-	1 (14)	-	5 (89)	1 (11)
Eschscholzia californica (ESCA2)	1 (11)	-	1 (17)	-	1 (20)
Galium parisiense (GAPA5)	-	-	1 (28)	-	-
Geranium dissectum (GEDI)	1 (16)	-	1 (22)	-	6 (44)
Geranium molle (GEMO)	-	1 (43)	1 (22)	-	2 (6)
Hemizonia congesta ssp. *l.* (HECOL)	-	-	-	-	6 (28)
Hypericum perforatum (HYPE)	-	-	1 (6)	-	-
Lagophylla sp. (LAGOP)	-	-	-	-	-
Limnanthes douglasii (LIDO)	1 (16)	-	3 (11)	-	-
Linanthus sp. (LINAN)	2 (7)	-	1 (63)	-	18 (100)
Linum bienne (LIBI5)	2 (79)	-	-	1 (78)	2 (22)
Lomatium sp. (LOMAT)	1 (42)	-	-	1 (22)	1 (33)
Lotus micranthus (LOMI)	10 (84)	-	-	-	-
Lotus sp. (LOTUS)	-	-	1 (63)	3 (78)	5 (11)
Lupinus bicolor (LUBI)	1 (37)	-	1 (17)	-	3 (6)
Madia sp. (MADIA)	2 (26)	1 (14)	4 (50)	-	1 (11)
Marah sp. (MARAH)	2 (53)	1 (29)	-	-	-
Mimulus guttatus (MIGU)	-	-	-	1 (11)	2 (22)
Navarettia sp.(NAVAR)	-	-	1 (6)	3 (11)	1 (6)
Plagiobothrys nothofulvus (PLNO)	-	-	2 (28)	-	15 (17)
Plantago lanceolata (PLLA)	2 63)	-	14 (6)	-	1 (6)
Plectritis brachystemon (PLBR6)	-	-	10 (17)	1 (11)	1 (6)

PLANT ASSOCIATION :	AREL3-CYEC /DICAC5 n=19	PHAQ-BRHO2 /CESO3 n=7	BRHO2-TACA8 /ERBO n=18	BRHO2-AICA /ERODI n=9	BRHO2 /LIDO-TRIFO n=17
Ranunculus occidentalis (RAOC)	1 (42)	-	3 (11)	1 (10)	5 (61)
Rumex acetosella (RUAC)	2 (84)	-	-	13 (22)	1 (11)
Rumex crispus (RUCR)	1 (5)	-	-	1(11)	2 (28)
Sanicula bipinnatifida (SABI3)	-	1 (29)	1 (22)	2 (30)	6 (11)
Sidalcea diploscytha (SIDI)	-	-	-	-	1 (11)
Sidalcea malvaeflora (SIMA2)	2 (26)	-	-	5 (22)	-
Taraxacum officinale (TAOF)	2 (63)	-	-	3 (44)	2(17)
Torilis arvensis (TOAR)	-	-	5 (65)	-	1 (6)
Torilis nodosa (TONO)	-	-	-	-	-
Trifolium bifidum ssp. *b.* (TRBIB)	-	-	1 (17)	-	8 (33)
Trifolium wildenovii (TRWI)	-	-	2 (33)	-	9 (39)
Trifolium sp. (TRIFO)	1 (53)	6 (56)	2 (75)	1 (11)	4 (33)
Tritelia laxa (TRLA16)	-	-	-	5 (11)	2 (11)
Verbena lasiostachys (VELA)	-	-	1 (6)	-	15 (6)
Vicia americana var. *a.* (VIAMA)	2 (63)	-	-	-	11 (11)
Wyethia angustifolia (WYAN)	-	-	1 (6)	-	1 (28)
Yabea microcarpa (YAMI)	-	3 (43)	-	-	1 (6)
Zigadenus sp. (ZIGAD)	-	2 (29)	-	-	-
GRAMINOIDS	**% COVER (CONSTANCY)**				
Achnatherum lemmonii (ACLE8)	1 (11)	-	-	3 (22)	-
Aira caryophyllea (AICA)	4 (89)	12 (57)	16 (69)	24 (100)	5 (61)
Arrhenatherum elatius (AREL3)	37 (100)	-	-	-	-
Avena barbata (AVBA)	-	-	-	6 (67)	2 (28)
Avena fatua (AVFA)	6 (47)	-	11 (33)	-	3 (6)
Briza minor (BRMI2)	-	-	1 (28)	-	1 (6)
Bromus carinatus (BRCA5)	-	-	1 (6)	5 (44)	-

PLANT ASSOCIATION :	AREL3-CYEC /DICAC5 n=19	PHAQ-BRHO2 /CESO3 n=7	BRHO2-TACA8 /ERBO n=18	BRHO2-AICA /ERODI n=9	BRHO2 /LIDO-TRIFO n=17
Bromus diandrus (BRDI3)	8 (11)	5 (71)	6 (39)	1 (22)	3 (50)
Bromus hordeaceus (BRHO2)	18 (89)	17 (100)	19 (100)	27 (100)	25 (100)
Bromus madritensis rubens (BRMAR)	-	1 (71)	2 (55)	6 (33)	6 (50)
Bromus tectorum (BRTE)	15 (5)	-	8 (11)	19 (67)	2 (28)
Cynosurus echinatus (CYEC)	28 (100)	-	19 (39)	3 (56)	9 (78)
Danthonia sp. (DANTH)	12 (11)	-	9 (22)	-	8 (33)
Elymus elymoides (ELEL)	-	-	-	1 (11)	-
Elymus glaucus (ELGL)	1 (5)	-	1 (6)	1 (11)	3 (11)
Hordeum marinum gusson. (HOMAG)	5 (2)	-	-	-	21 (72)
Juncus sp. (JUNCU)	1 (21)	-	10 (11)	-	1 (59)
Juncus patens (JUPA2)	-	-	-	1 (11)	6 (15)
Koehleria macrantha (KOMA)	-	2 (88)	-	-	-
Luzula comosa (LUCO6)	1 (53)	-	1 (6)	-	1(17)
Phalaris aquatica (PHAQ)	-	40 (100)	-	-	-
Poa sp. (POA)	2 (37)	1 (29)	1 (22)	1 (33)	2 (22)
Taeniatherum caput-medusae (TACA8)	-	-	30 (100)	-	-
Ventenata dubia (VEDU)	-	-	-	-	-
Vulpia microstachys (VUMI)	-	9 (43)	1 (17)	-	5 (6)
Vulpia myuros (VUMY)	-	-	1 (17)	1 (11)	1 (6)
Vulpia sp. (VULPI)	-	1 (14)	1 (11)	3 (33)	10 (6)

PLANT ASSOCIATION :	BRHO2 -BRTE n=9	BRHO2 /ERBO n=10	BRHO2-AICA /DICAC5 n=41	BRHO2/DIMU5- -GRCA n=5	CYEC-BRHO2 -BRDI3/TAOF n=13
TOTAL % COVER	70	85	77	86	90
GRASS % COVER	55	64	45	83	74
FORB % COVER	26	47	43	13	41
SHRUB % COVER	0	0	0	0	0
TREE % COVER	0	0	0	0	0
TREE OVERSTORY:					
Negligible					
TREE UNDERSTORY:					
Negligible					
SHRUBS:					
Ceanothus cuneatus (CECU)	-	-	-	-	-
FORBS					
Achillea millefolium (ACMI)	-	-	5 (2)	-	-
Agoseris sp. (AGOSE)	1 (89)	1 (50)	1 (5)	1 (40)	-
Amsinkia sp. (AMS1)	1 (44)	1 (10)	-	-	-
Brodiaea sp. (BRODI)	-	3 (10)	-	-	-
Calochortus tolmei (CATO)	1 (11)	-	-	-	-
Castilleja attentuata (CAAT25)	1 (33)	-	1 (22)	-	-
Cerastium glomeratum (CEGL)	1 (78)	5 (10)	2 (41)	1 (20)	1 (50)
Centaurea solstitialis (CESO3)	-	1 (40)	-	-	13 (33)
Chlorogalum pomeridianum (CHPO2)	1 (22)	28 (30)	3 (7)	1 (20)	1 (33)
Clarkia sp. (CLARK)	1 (22)	-	6 (88)	1 (60)	4 (83)
Cynoglossom grande (CYGR)	-	1 (40)	-	-	-

PLANT ASSOCIATION :	BRHO2 -BRTE	BRHO2 /ERBO	BRHO2-AICA /DICAC5	BRHO2/DIMU5 -GRCA	CYEC-BRHO2 -BRDI3/TAOF
	n=9	n=10	n=41	n=5	n=13
Dichelostemma capitatum (DICAC5)	1 (67)	-	2(88)	-	1 (83)
Dichelostemma volubile (DIVO)	-	1 (20)	-	-	-
Draba verna (DRVE2)	1 (56)	1 (25)	-	-	-
Epilobium sp. (EPILO)	1 (11)	-	1 (2)	1 (60)	-
Erodium botrys (ERBO)	4 (78)	1 (30)	4 (54)	1 (20)	-
Erodium cicutarium (ERCI6)	9 (44)	10 (90)	5 (32)	1 (60)	-
Erodium sp. (ERODI)	-	6 (20)	-	-	2 (83)
Eschscholzia californica (ESCA2)	-	1 (17)	1 (12)	1 (20)	-
Galium parisiense (GAPA2)	-	-	1 (2)	-	-
Geranium dissectum (GEDI)	6 (40)	3 (30)	4 (22)	-	-
Geranium molle (GEMO)	-	40 (10)	3 (46)	-	-
Hemizonia congesta luzul. (HECOL)	-	21 (20)	1 (7)	-	2 (33)
Hypericum perforatum (HYPE)	-	-	-	-	-
Lagophylla sp. (LAGOP)	1 (11)	-	1 (2)	-	-
Limnanthes douglasii (LIDO)	1 (22)	-	4 (59)	-	7 (83)
Linanthus sp. (LINAN2)	-	-	2 (5)	3 (40)	-
Linum bienne (LIBI5)	-	-	2 (37)	-	2 (67)
Lomatium sp. (LOMAT)	1 (22)-	1 (40)	11 (20)	1 (20)	1 (17)
Lotus micranthus (LOMI)	1 (44)	-	8 (81)	-	-
Lotus sp. (LOTUS)	2 (78)	1 (10)	4 (20)	1 (40)	-
Lupinus bicolor (LUBI)	1 (11)	4 (80)	6 (26)	2 (80)	6 (26)
Madia sp. (MADIA)	-	2 (40)	-	5 (20)	-
Marah sp. (MARAH)	-	1 (30)	-	-	-
Mimulus guttatus (MIGU)	-	-	2 (29)	-	-
Navarettia sp.(NAVAR)	-	-	-	-	-
Plagiobothrys nothofulvus (PLNO)	3 (56)	-	2 (12)	-	-
Plantago lanceolata (PLLA)	1 (22)	1 (10)	2 (21)	-	2 (67)

PLANT ASSOCIATION :	BRHO2 -BRTE n=9	BRHO2 /ERBO n=10	BRHO2-AICA /DICAC5 n=41	BRHO2/DIMU5 -GRCA n=5	CYEC-BRHO2 -BRDI3/TAOF n=13
Plectritis brachystemon (PLBR6)	1 (11)	1 (10)	2 (9)	-	4 (67)
Ranunculus occidentalis (RAOC)	5 (22)	3 (30)	4 (7)	1 (20)	-
Rumex acetosella (RUAC)	-	-	-	-	-
Rumex crispus (RUCR)	2 (44)	-	2 (29)	-	5 (67)
Sanicula bipinnatifida (SABI3)	-	-	2 (41)	1 (20)	-
Sidalcea diploscytha (SIDI)	-	1 (10)	-	-	5 (17)
Sidalcea malvaeflora (SIMA)	-	-	2 (2)	-	9 (100)
Taraxacum officinale (TAOF)	2 (67)	-	1 (2)	-	-
Torilis arvensis (TOAR)	-	-	3 (5)	6 (80)	-
Torilis nodosa (TONO)	-	2 (20)	9 (61)	-	-
Trifolium bifidum ssp. *b.* (TRBIB)	1 (44)	-	6 (71)	-	-
Trifolium willdenovii (TRWI)	1 (78)	-	14 (85)	2 (20)	1 (83)
Trifolium sp. (TRIFO)	1 (22)	2 (10)	-	3 (60)	-
Tritelia laxa (TRLA16)	1 (11)	4 (70)	-	-	-
Verbena lasiostachys (VELA)	1 (11)	-	3 (2)	1 (20)	-
Vicia americana var. *a.* (VIAMA)	-	-	5 (24)	1 (40)	-
Wyethia angustifolia (WYAN)	1 (44)	1 (10)	-	-	-
Yabea microcarpa (YAMI)	-	-	-	-	-
Zigadenus sp. (ZIG)	-	-	-	-	-
GRAMINOIDS					
Achnatherum lemmonii (ACLE8)	5 (33)	1 (30)	1 (2)	12 (80)	-
Aira caryophyllea (AICA)	8 (78)	2 (40)	7 (93)	20 (40)	2 (50)
Arrhenatherum eliatus (AREL3)	-	-	-	-	-
Avena barbata (AVBA)	8 (22)	-	6 (68)	1 (20)	1 (50)
Avena fatua (AVFA)	10 (11)	15 (90)	1 (5)	3 (60)	-
Briza minor (BRMI2)	-	-	1 (7)	-	-

PLANT ASSOCIATION :	BRHO2 -BRTE n=9	BRHO2 /ERBO n=10	BRH02-AICA /DICAC5 n=41	BRHO2/DIMU5- GRCA n=5	CYEC-BRHO2 BRDI3/TAOF n=13
Bromus carinatus (BRCA5)	-	-	1 (7)	1 (20)	4 (50)
Bromus diandrus (BRDI3)	1 (22)	-	5 (44)	1 (40)	2 (100)
Bromus hordeaceus (BRHO2)	17 (100)	19 (100)	20 (100)	28 (100)	28 (100)
Bromus madritensis ssp. *rubens* (BRMAR)	-	15 (70)	7 (39)	1 (20)	-
Bromus tectorum (BRTE)	12 (100)	-	10 (80)	1 (60)	3 (33)
Cynosurus echinatus (CYEC)	14 (44)	-	7 (68)	-	47 (100)
Danthonia sp. (DANTH)	-	3 (22)	1 (5)	-	2 (33)
Elymus elymoides (ELEL)	-	-	-	-	-
Elymus glaucus (ELGL)	-	1 (10)	2 (7)	6 (40)	4 (83)
Hordeum marinum ssp. *gusson.* (HOMAG)	-	33 (20)	23 (5)	-	-
Juncus sp. (JUNCU)	-	1 (30)	1 (2)	-	1 (17)
Juncus patens (JUPA2)	-	-	-	-	-
Koehleria macrantha (KOMA)	-	-	-	-	-
Luzula comosa (LUCO6)	-	-	2 (2)	-	-
Phalaris aquatica (PHAQ)	-	-	-	-	-
Poa sp. (POA)	2 (44)	16 (30)	1 (19)	14 (100)	1 (83)
Taeniatherum caput-medusae (TACA8)	9 (33)	1 (10)	-	19 (60)	1 (17)
Ventenata dubia (VEDU)	-	-	-	-	-
Vulpia microstachys (VUMI)	3 (22)	3 (50)	5 (12)	1 (20)	-
Vulpia myuros (VUMY)	1 (11)	2 (60)	1 (5)	16 (40)	-
Vulpia sp. (VULPI)	-	1 (20)	-		-

PLANT ASSOCIATION :	CYEC/LAGOP //Rocky n=12	CYEC-BRHO2 /HECOL-MAEL n=15	CYEC-BRHO2 -TACA8 n=24	CYEC-BRHO2 -BRTE n=8	CYEC-BRHO2 -AVFA n=10
TOTAL % COVER	95	93		77	
GRASS % COVER	76	51	61	54	70
FORB % COVER	30	43	19	23	36
SHRUB % COVER	0	0	0	0	1
TREE % COVER	0	0	0	0	0
TREE OVERSTORY:	**% COVER (CONSTANCY)**				
Negligible					
TREE UNDERSTORY:	**% COVER (CONSTANCY)**				
Negligible					
SHRUBS:	**% COVER (CONSTANCY)**				
Ceanothus cuneatus (CECU)	-	-	-	-	-
FORBS	**% COVER (CONSTANCY)**				
Achillea millefolium (ACMI)	5 (75)	1 (53)	1 (25)	-	2 (30)
Agoseris sp. (AGOSE)	-	-	2 (38)	1 (25)	1 (30)
Amsinkia sp. (AMS1)	-	1 (40)	1 (4)	3 (25)	-
Brodiaea sp. (BRODI)	-	-	1 (4)	-	1 (20)
Calochortus tolmei (CATO)	2 (67)	-	1 (4)	-	-
Castilleja attentuata (CAAT25)	-	1 (20)	1 (8)	1 (13)	-
Cerastium glomeratum (CEGL)	-	-	1 (33)	1 (25)	-
Centaurea solstitialis (CESO3)	-	-	10 (4)	-	1 (30)
Chlorogalum pomeridianum (CHPO2)	1 (50)	1 (13)	1 (17)	-	1 (40)
Clarkia sp. (CLARK)	5 (92)	1 (44)	1 (42)	-	1 (10)
Cynoglossom grande (CYGR)	-	-	1 (4)	-	-
Dichelostemma capitatum (DICAC5)	-	1 (80)	1 (50)	1 (25)	-

PLANT ASSOCIATION :	CYEC/LAGOP //Rocky n=12	CYEC-BRHO2 /HECOL-MAEL n=15	CYEC-BRHO2 -TACA8 n=24	CYEC-BRHO2 -BRTE n=8	CYEC-BRHO2 -AVFA n=10
Dichelostemma volubile (DIVO)	-	-	-	-	-
Draba verna (DRVE2)	-	-	1 (13)	-	-
Epilobium sp. (EPILO)	-	-	1 (29)	1 (50)	-
Erodium botrys (ERBO)	-	1 (7)	1 (21)	3 (88)	7 (50)
Erodium cicutarium (ERCI6)	-	1 (13)	1 (17)	-	-
Erodium sp. (ERODI)	-	-	4 (4)	1 (38)	-
Eschscholzia californica (ESCA2)	-	1 (13)	1 (4)	-	2 (10)
Galium parisiense (GAPA2)	-	-	1 (54)	1 (25)	-
Geranium dissectum (GEDI)	-	-	1 (17)	1 (13	)-
Geranium molle (GEMO)	-	-	7 (25)	-	1 (10)
Hemizonia congesta luzul. (HECOL)	2 (8)	22 (93)	1 (42)	10 (13	)-
Hypericum perforatum (HYPE)	-	1 (80)	-	3 (25)	-
Lagophylla sp. (LAGOP)	7 (100)	-	-	-	-
Limnanthes douglasii (LIDO)	-	1 (7)	1 (13)	1 (13)	2 (70)
Linanthus sp. (LINAN2)	-	1 (20)	-	2 (13)	1 (40)
Linum bienne (LIBI5)	-	-	-	-	12 (80)
Lomatium sp. (LOMAT)	1 (46)	1 (93)	1 (17)		--
Lotus micranthus (LOMI)	1 (17)	1 (20)	1 (13)	5 (63)	1 (20)
Lotus sp. (LOTUS)	1 (8)	1 (13)	1 (13)	-	1 (70)
Lupinus bicolor (LUBI)	-	1 (20)	1 (21)	1 (63)	6 (20)
Madia sp. (MADIA)	10 (8)	1 (80)	-	3 (63	)-
Marah sp. (MARAH)	1 (25)	2 (7)	-	2 (25	)-
Mimulus guttatus (MIGU)	-	-	-	-	3 (70)
Navarettia sp.(NAVAR)	-	-	-	-	-
Plagiobothrys nothofulvus (PLNO)	-	-	1 (33)	1 (25)	1 (40)
Plantago lanceolata (PLLA)	-	-	1 (13)	-	7 (60)
Plectritis brachystemon (PLBR6)	-	1 (7)	1 (25)	-	-

PLANT ASSOCIATION :	CYEC/LAGOP //Rocky n=12	CYEC-BRHO2 /HECOL-MAEL n=15	CYEC-BRHO2 -TACA8 n=24	CYEC-BRHO2 -BRTE n=8	CYEC-BRHO2 -AVFA n=10
Ranunculus occidentalis (RAOC)	-	1 (40)	3 (42)	-	1 (10)
Rumex acetosella (RUAC)	2 (58)	1 (33)	-	8 (50)	-
Rumex crispus (RUCR)	-	1 (27)	1 (8)	1 (13)	-
Sanicula bipinnatifida (SABI3)	-	1(33)	-	-	-
Sidalcea diploscytha (SIDI)	-	2 (53)	1 (8)	-	3 (100)
Sidalcea malvaeflora (SIMA)	-	-	2 (4)	-	1 (20)
Taraxacum officinale (TAOF)	1 (58)	-	3 (58)	-	-
Torilis arvensis (TOAR)	-	-	-	2 (38)	-
Torilis nodosa (TONO)	-	1 (67)	-	-	-
Trifolium bifidum ssp. *b.* (TRBIB)	-	1 (53)	1 (33)	-	4 (30)
Trifolium willdenovii (TRWI)	-	2 (80)	3 (74)	-	-
Trifolium sp. (TRIFO)	1 (17)	2 (40)	1 (22)	10 (13)	-
Tritelia laxa (TRLA16)	-	2 (53)	1 (4)	1 (13)	1 (20)
Verbena lasiostachys (VELA)	-	-	1 (4)	1 (25)	1 (10)
Vicia americana var. *a.* (VIAMA)	-	1 (47)	5 (33)	-	-
Wyethia angustifolia (WYAN)	2 (25)	6 (40)	-	-	-
Yabea microcarpa (YAMI)	-	1 (7)	-	-	-
Zigadenus sp. (ZIG)	-	-	-	-	-
GRAMINOIDS	**% COVER (CONSTANCY)**				
Achnatherum lemmonii (ACLE8)	5 (58)	-	5 (33)	1 (38)	4 (10)
Aira caryophyllea (AICA)	11 (50)	1 (53)	13 (67)	8 (88)	5 (80)
Arrhenatherum eliatus (AREL3)	-	9 (20)	-	-	2 (40)
Avena barbata (AVBA)	11 (67)	5 (87)	3 (33)	-	-
Avena fatua (AVFA)	-	-	6 (42)	3 (25)	13 (70)
Briza minor (BRMI2)	-	1 (7)	-	2 (13)	-
Bromus carinatus (BRCA5)	-	4 (40)	7 (21)	1 (14)	10 (35)

PLANT ASSOCIATION :	**CYEC/LAGOP //Rocky** n=12	**CYEC-BRHO2 /HECOL-MAEL** n=15	**CYEC-BRHO2 -TACA8** n=24	**CYEC-BRHO2 -BRTE** n=8	**CYEC-BRHO2 -AVFA** n=10
Bromus diandrus (BRDI3)	5 (50)	1 (27)	2 (33)	-	13 (70)
Bromus hordeaceus (BRHO2)	2 (58)	6 (100)	8 (98)	14 (100)	21 (90)
Bromus madritensis rubens (BRMAR)	-	1 (7)	-	-	-
Bromus tectorum (BRTE)	9 (58)	1 (27)	5 (58)	24 (100)	2 (30)
Cynosurus echinatus (CYEC)	53 (100)	16 (100)	24 (100)	21 (100)	26 (100)
Danthonia sp. (DANTH)	-	7 (27)	4 (38)	1 (13)	4 (10)
Elymus elymoides (ELEL)	2 (25)	25 (7)	-	-	-
Elymus glaucus (ELGL)	4 (67)	2 (60)	5 (54)	-	1 (10)
Hordeum marinum gusson. (HOMAG)	2 (17)	-	8 (20)	-	-
Juncus sp. (JUNCU)	-	1 (13)	1 (17)	2 (13)	1 (10)
Juncus patens (JUPA2)	-	-	-	-	1 (10)
Koehleria macrantha (KOMA)	-	-	-	-	-
Luzula comosa (LUCO6)	-	1 (7)	1 (4)	-	1 (10)
Phalaris aquatica (PHAQ)	-	-	-	-	-
Poa sp. (POA)	1 (8)	1 (40)	1 (46)	1 (25)	1 (40)
Taeniatherum caput-medusae (TACA8)	-	7 (73)	9 (71)	8 (25)	-
Ventenata dubia (VEDU)	-	-	80 (4)	-	-
Vulpia microstachys (VUMI)	-	-	-	-	-
Vulpia myuros (VUMY)	-	-	1 (8)	3 (38)	-
Vulpia sp. (VULPI)	-	-	-	1 (13)	-

ANNUAL GRASSLANDS
Soil Summary*
Mean (Range)

PLANT ASSOCIATION	SOIL DEPTH (in.)	AWC (in.)	PARENT MATERIAL	SURFACE pH	A-HORIZON THICKNESS (in)	COARSE FRAG (%)	TEXTURE
AREL3-CYEC/FORB	38 (26-41)	5 (0-3)	SA	6 (6-7)	13 (5-34)	25 (10-50)	gcl, gl, l, sil
PHAQ-BRHO2/CESO3	53 (45-60)	3 (2-3)	RH	7 (7)	10 (8-12)	20 (15-20)	cosl
BRHO2-TACA8/ERBO	39 (33-60)	3 (2.5-3)	SA	7 (6.5-7)	9 (3-14)	18 (2-27)	gl, l
BRHO2-AICA/ERODI	35 (4-41)	2 (1-4)	SA	6.5 (6-7)	10 (4-14)	16 (8-25)	cl, gfsl, gsl, l
BRHO2/LIDO-TRIFO	38 (27-60)	3 (2-4)	SA, SI	7 (6-7)	10 (4-36)	8 (4-10)	cl, l, sil
BRHO2/ERBO	31 (16-60)	2.5 (2-3)	SA	7 (6.5-7)	11 (6-22)	22 (5-40)	cl, gcl, gl
BRHO2-AICA/DICAC5	31 (4-41)	2.5 (1-3)	SA	6 (5.5-7)	10 (3-24)	19 (10-35)	gl, gsl, l, sicl
BRHO2-BRTE	30 (25-25)	3 (2.5-3)	SA, SH	7 (7)	6 (4-10)	25 (20-30)	cl
CYEC-BRHO2-BRDI3/TAOF	41 (41)	2 (2-3)	SA	6.5 (6-7)	5 (2-6)	17 (15-20)	gcl, gfsl, gl
CYEC-BRHO2-TACA8	41 (41)	3 (2-3)	SA, AR	6 (6)	9 (5-12)	21 (20-22)	gcl
CYEC-BRHO2-BRTE	31 (25-38)	3 (2.5-3)	SA	7 (6.5-7)	6 (4-9)	25 (20-30)	cl
CYEC-BRHO2-AVFA	37 (21-41)	2.5 (2-3)	SA	6 (5.5-7)	11 (4-17)	22 (7-36)	gl, l, vgl
CYEC/LAGOP//Rocky	25 (22-31)	3 (2-3)	SA	6 (6-7)	8 (3-16)	28 (7-75)	gl, gsil
CYEC-BRHO2/HECOL-MAEL	41 (41)	2 (1.5-3)	SA, CH	6 (6-7)	10 (5-15)	19 (12-31)	gl, l

Parent Material:
AR - Argillite
CH - Chert
RH - Rhyollite
SA - Sandstone
SH - Shale
SI - Siltstone
* see Annual Grassland Introduction, Pages 3-5 for definitions

MEAN VALUES FOR ENVIRONMENTAL VARIABLES BY PLANT ASSOCIATION IN THE ANNUAL GRASSLANDS

TYPE:	AREL3-CYEC/DICAC5	PHAQ-BRHO2/CESO3	BRHO2-TACA8/ERBO	BRHO2-AICA/EROD	BRHO2/LIDO-TRIFO	BRHO2/ERBO	BRHO2-AICA-DICAC5	BRHO2/DIMU5-GRCA
# of Plots	19	2	19	9	17	10	41	5
Precip in.	77	45	50	61	64	48	65	41
Dist miles	29	57	44	30	35	57	33	55
Elev ft.	3143	2350	3101	3153	2718	3601	2695	3995
Slope %	19	19	26	30	21	29	36	23
Rock %	1	4	1	3	1	1	2	3
Grvl %	2	1	7	7	1	5	7	1
Bare %	2	2	9	12	7	8	12	3
Moss %	10	1	1	0	2	0	0	0
LIT %	86	5	27	0	5	8	10	56
LITTHK in.	0.4	1.0	0.6	0	0.2	1.2	0.1	0.5
RI	.500	.500	.500	.524	.506	.550	.551	.503
TFCOV %	31	30	36	51	65	58	51	26
TGCOV %	94	74	78	76	72	20	52	96
TSCOV %	1	3	0	0	0	0	0	0
TTCOV %	0	0	0	0	0	0	0	0
TODPTH in.	38	53	39	35	38	31	31	-
AHTHK in.	13	10	9	10	10	11	10	-
AHCFG %	25	20	18	16	8	22	19	-
SUR pH	6	7	7	6.5	7	7	6	-
SSCFG %	25	12	24	34	25	33	26	-

MEAN VALUES FOR ENVIRONMENTAL VARIABLES BY PLANT ASSOCIATION IN THE ANNUAL GRASSLANDS

TYPE:	BRHO2-BRTE	CYEC-BRHO2-(BRDI3)/TAOF	CYEC-BRHO2 TACA8	CYEC-BRHO2-BRTE	CYEC-BRHO2AVFA	CYEC/LAGOP//ROCKY	CYEC-BRHO2/HECOL-MAEL
# of Plots	9	6	24	8	10	12	15
Precip in.	64	55	65	64	76	76	65
Dist miles	41	30	37	40	28	34	37
Elev ft.	3684	3220	3185	3784	2876	3813	3282
Slope %	30	29	19	23	22	30	23
Rock %	2	2	1	1	1	11	1
Grvl %	14	1	5	9	2	26	3
Bare %	25	8	11	15	3	4	3
Moss %	1	1	1	1	2	0	0
LIT %	10	0	9	6	92	29	1
LITTHK in.	0.2	0	0.3	0.2	0.4	0.1	0.4
RI	.506	.489	.486	.527	.517	.502	.476
TFCOV %	27	49	23	23	41	32	57
TGCOV %	53	87	68	54	78	81	45
TSCOV %	0	0	0	0	1	1	0
TTCOV %	0	0	0	0	0	0	0
TODPTH in.	30	41	41	31	37	25	41
AHTHK in.	6	5	9	6	11	8	10
AHCFG %	25	17	21	25	22	28	19
SUR pH	7	6.5	6	7	6	6	6
SSCFG %	20	27	33	20	29	64	40

ECOLOGICAL STATUS BY PLANT ASSOCIATION IN THE ANNUAL GRASSLANDS (% MEAN COVER)

ASSOCIATION:	AREL3-CYEC/ DICAC5	PHAQ-BRHO2/ CESO3	BRHO2- TACA8/ERBO	BRHO2- AICA/ERODI	BRHO2/ LIDO-TRIFO	BRHO2/ ERBO	BRHO2- AICA/DICAC5
FORBS:							
Native annual	11.8	5.9	19.9	20.9	34.3	17.4	35.8
Exotic annual	2.1	21.4	9.5	8.4	14.0	36.4	6.7
Total annual	13.9	27.3	29.4	29.3	48.3	53.8	42.5
Native perennial	11.2	2.6	6.3	11.4	14.8	3.9	7.7
Exotic perennial	6.2	0.0	0.5	10.6	2.1	0.2	1.2
Total perennial	17.4	2.6	6.8	22.0	16.9	4.1	8.9
Total Forb	31.3	29.9	36.2	51.3	65.2	57.9	51.4
R5 Seral Stage:							
Early	24.1	24.1	23.1	37.4	31.0	43.7	38.2
Mid	4.6	3.9	9.4	8.7	13.6	12.2	15.9
Late	2.4	1.4	1.7	3.1	22.7	1.4	2.7
GRASSES:							
Native annual	0.0	4.0	0.2	0.0	0.5	2.1	0.6
Exotic annual	52.7	27.9	65.3	73.8	57.9	58.8	50.7
Total annual	52.7	31.9	65.5	73.8	58.4	60.9	51.3
Native perennial	3.1	1.6	12.1	1.6	12.8	9.0	0.5
Exotic perennial	38.4	40.3	0.1	0.6	1.3	0.1	0.0
Total perennial	41.4	41.9	12.2	2.1	14.1	9.1	0.5
Total Grass	94.1	73.8	77.7	76.0	72.5	70.0	51.8
R5 Seral Stage:							
Early	90.3	72.1	64.2	74.0	59.0	61.0	51.3
Mid	2.6	0.0	2.3	0.4	5.6	1.0	0.2
Late	1.2	0.3	7.9	1.3	5.8	2.2	0.3
1-5 Year Disturbance State:							
High	4.2	6.6	9.1	36.7	20.7	8.4	16.7
Medium	0.0	2.0	0.7	2.4	0.1	5.9	3.2
Low	23.6	20.3	27.7	33.9	39.8	47.1	26.7

ECOLOGICAL STATUS BY PLANT ASSOCIATION IN THE ANNUAL GRASSLANDS (% MEAN COVER)

ASSOCIATION:	BRHO2-BRTE	BRHO2/DIMU5-GRCA	CYEC-BRHO2--BRDI3/TAOF	CYEC-BRHO2 TACA8	CYEC-BRHO2-BRTE	CYEC-BRHO2 AVFA	CYEC/LAGOP //ROCKY	CYEC-BRHO2/HECOL-MAEL
FORBS:								
Native annuals	10.8	9.2	14.0	7.8	10.8	14.5	15.3	45.3
Exotic annuals	8.4	7.6	5.8	4.0	4.6	11.8	0.2	1.9
Total annuals	19.2	16.8	19.8	11.8	15.4	26.3	15.5	47.2
Native perennials	6.3	9.2	13.0	9.2	4.6	4.0	10.0	7.9
Exotic perennials	1.3	0.0	16.5	2.3	5.0	11.1	6.2	1.9
Total perennials	7.7	9.2	29.5	11.5	9.6	15.1	16.2	9.8
Total Forb	27.0	26.0	49.3	23.3	25.0	41.4	31.7	57.0
R5 Seral Stage:								
Early	18.4	18.4	38.5	13.9	20.8	34.8	19.9	47.3
Mid	6.3	4.0	9.3	7.1	2.9	5.0	5.4	8.5
Late	2.0	1.4	1.5	1.3	1.0	1.3	5.8	1.7
GRASSES:								
Native annuals	0.7	0.2	0.0	0.1	0.0	0.0	0.0	0.0
Exotic annuals	47.6	56.8	80.3	58.3	53.0	69.8	74.3	34.3
Total annuals	48.2	57.0	80.3	58.4	53.0	69.8	74.3	34.3
Native perennials	2.6	24.6	5.7	9.5	1.0	4.7	6.6	8.5
Exotic perennials	1.8	14.2	1.2	0.5	0.4	1.7	0.1	2.0
Total perennials	4.3	38.8	6.8	10.0	1.4	6.4	6.6	10.5
Total Grass	52.5	95.6	87.0	68.4	54.4	75.2	81.0	45.0
R5 Seral Stage:								
Early	50.0	49.0	80.5	56.1	53.4	71.0	74.7	36.1
Mid	0.1	10.8	6.3	6.1	0.3	4.4	3.0	6.1
Late	1.9	27.8	0.3	2.0	0.6	0.7	3.3	2.6
1-5 Year Disturbance State:								
High	18.2	8.6	2.2	13.0	13.6	5.7	11.1	1.0
Medium	0.1	0.6	0.2	0.1	1.3	0.0	0.0	0.1
Low	22.0	60.4	36.0	19.2	15.6	39.3	16.7	16.4

ANNUAL GRASSLAND NOXIOUS WEED COMPARISON TABLE

	% COVER (CONSTANCY)							
PLANT COMMUNITY:	**BRMAR**	**BRTE**	**CEME2**	**CESO3**	**CIVU**	**TACA8**	**HYPE**	**MEPU**
PHAQ-BRHO2/CESO3	1(71)	-	-	14 (100)	-	-	-	-
AREL3-CYEC/DICAC5	-	5 (15)	-	-	-	-	-	-
BRHO2-TACA8/ERBO	2 (22)	8 (11)	-	11 (28)	-	26 (100)	1 (6)	-
BRHO2-AICA/ERODI	-	19 (67)	-	6 (44)	-	-	-	-
BRHO2/LIDO-TRIFO	-	2 (28)	-	-	1 (11)	10 (6)	-	-
BRHO2/ERBO	10 (40)	-	-	28 (30)	-	1 (10)	-	-
BRHO2-AICA/DICAC5	39 (7)	10 (80)	-	-	-	-	1 (7)	-
BRHO2-BRTE-AICA	-	12 (100)	-	-	-	9 (33)	-	-
BRHO2/DIMU5-GRCA	1 (20)	1 (60)	-	-	-	19 (60)	-	-
CYEC-BRHO2/TAOF	1 (17)	3 (33)	-	13 (33)	-	-	2 (33)	-
CYEC-BRHO2-TACA8	-	5 (58)	1 (8)	4 (10)	-	9 (71)	1 (42)	-
CYEC-BRHO2-BRTE	-	7 (88)	-	-	-	8 (25)	3 (25)	1 (13)
CYEC-BRHO2-AVFA	-	3 (30)	-	1 (30)	-	-	1 (10)	-
CYEC/LAGOP//Rocky	-	9 (58)	-	-	1 (8)	-	-	-
CYEC/HECOL/-MAEL	-	1 (27)	-	-	-	7 (73)	1 (80)	-

BRMAR – *Bromus madritensis* ssp. *rubens*
BRTE – *Bromus tectorum*
CEME2 – *Centaurea melitensis*
CESO3 – *Centaurea solstitialis*
CIVU – *Cirsium vulgare*
TACA8 – *Taeniatherum caput-medusae*
HYPE – *Hypericum perforatum*
MEPU – *Mentha pulegium*

EcoClass Codes for Plant Associations in the Annual Grasslands

EcoClass Code	EDP Code	Plant Association Name
GATAHD01	AREL-CYEC-DICAC5	*Arrhenatherum elatius-Cynosurus echinatus/Dichelostemma capitatum* ssp. *capitatum*
GAHGSC01	PHAQ-BRHO2-CESO3	*Phalaris aquatilis-Bromus hordeaceus/Centaurea solstitialis*
GASCFX01	BRHO2/LIDO/TRIFO	*Bromus hordeaceus/Limnanthes douglasii-Trifolium* spp.
GASCFX02	BRHO2-AICA/ERODI	*Bromus hordeaceus-Aira caryophyllea-Erodium* spp.
GASCFX03	BRHO2-AICA-DICAC5	*Bromus hordeaceus-Aira caryophyllea-Dichelostemma capitatum* ssp. *capitatum*
GASCFX04	BRHO2-TACA8/ERBO	*Bromus hordeaceus-Taeniatherum caput-medusae/Erodium botrys*
GASCFX05	BRHO2-BRTE	*Bromus hordeaceus-Bromus tectorum*
GASCFX06	BRHO2/ERBO	*Bromus hordeaceus/Erodium botrys*
GASCFXO7	BRHO2/DIMU5-GRCA	*Bromus hordeaceus/Dichelostemma multiflorum-Grindelia camporum*
GAHDFXO1	CYEC/HECOL-MAEL	*Cynosurus echinatus/Hemizonia congesta* ssp. *luzulaefolia-Madia elegans*
GAHDFX02	CYEC-BRHO2/TAOF	*Cynosurus echinatus-Bromus hordeaceus/Taraxacum officinale*
GAHDFX03	CYEC/LAGOP//Rocky	*Cynosurus echinatus/Lagophylla* sp.//Rocky
GAHDFX04	CYEC-BRHO2-AVFA	*Cynosurus echinatus-Bromus hordeaceus-Avena fatua*
GAHDFX05	CYEC-BRHO2-TACA8	*Cynosurus echinatus-Bromus hordeaceus-Taeniatherum caput-medusae*
GAHDFX06	CYEC-BRHO2-BRTE	*Cynosurus echinatus-Bromus hordeaceus-Bromus tectorum*

PLANTS WITH HISTORIC AND CONTEMPORARY USES IN THE ANNUAL GRASSLAND SERIES

EDP	SCIENTIFIC NAME	COMMON NAME	USES: HISTORIC	CONTEMPORARY	COMMERCIAL
ACMI2	*Achillea millefolium*	yarrow	X	X	X
ALLIU	*Allium* sp.	wild onion	X	X	
ANGEL	*Angelica* sp.	angelica	X	X	
APCA	*Apocynum cannabinum*	Indian hemp	X	X	
ARPA6	*Arctostaphylos patula*	greenleaf manzanita	X	X	X
AVFA	*Avena fatua*	wild oat	X	X	
BRDI	*Bromus diandrus*	ripgut brome	X		
BREL	*Brodiaea elegans*	harvest brodiaea	X	X	
BRHO2	*Bromus hordeaceus*	soft chess	X		
CAMI5	*Castilleja miniata*	Indian paintbrush	X		
CAOC	*Calystegia occidentalis*	bindweed	X		
CABU2	*Capsella bursa-pastoris*	shepherd's purse	X		X
CECU	*Ceanothus cuneatus*	buckbrush	X	X	
CHPO3	*Chlorogalum pomeridianum*	soaproot	X	X	
CIRSI	*Cirsium* sp.	thistle	X		
CLPE	*Claytonia perfoliata*	miners lettuce	X	X	
DEDET	*Delphinium decorum* ssp. *tracyi*	coast larkspur	X		
DEEL	*Deschampsia elongata*	slender hairgrass	X		
ELGL	*Elymus glaucus*	blue wildrye	X		
EQAR	*Equisetum arvense*	common scouring rush	X	X	X
EQLA	*Equisetum laevigatum*	Braun's scouring rush	X	X	X
ESCA2	*Eschscholzia californica*	California poppy	X		
GRCA	*Grindelia camporum*	gum plant	X		

EDP	SCIENTIFIC NAME	COMMON NAME	USES: HISTORIC	CONTEMPORARY	COMMERCIAL
HODI	*Holodiscus discolor*	oceanspray	X		
HYPE	*Hypericum perforatum*	St. John's wort		X	
IRMA	*Iris macrosiphon*	slendertube iris	X	X	
JUEF	*Juncus ensifolius*	bog rush	X		
JUOC	*Juniper occidentalis*	western juniper	X	X	
LIGUS	*Ligusticum* sp.	wild celery	X		
LOHU2	*Lotus humistratus*	hill lotus	X		
MADIA	*Madia* sp.	tarweed	X		
MEAR4	*Mentha arvensis*	field mint	X		
MOOD	*Monardella odoratissima*	coyote mint	X	X	
PEKE	*Perideridia kelloggii*	Kellogg's yampah	X		
PETR7	*Pentagramma triangularis*	goldenback fern	X		
PIPO	*Pinus ponderosa*	ponderosa pine	X	X	X
PLLA	*Plantago lanceolata*	plantain	X	X	
POMU	*Polystichum munitum*	sword fern	X	X	X
PRVU	*Prunella vulgaris* var. *lanceolatum*	mountain self-heal		X	X
PSME	*Pseudotsuga menziesii*	Douglas-fir	X	X	X
PTAQP	*Pteridium aquilinum*	bracken fern	X	X	X
QUGA4	*Quercus garryana*	Oregon white oak	X		
RIBES	*Ribes* sp.	current, gooseberry	X	X	X
RUBUS	*Rubus* sp.	black or raspberry	X	X	
RUAC	*Rumex acetosella*	sheep sorrel	X	X	
RUCR	*Rumex crispus*	curlydock	X	X	
SABI2	*Sanicula bipinnata*	poison sanicle	X		
SIMA2	*Sidalcea malvaeflora*	mallow	X		

EDP	SCIENTIFIC NAME	COMMON NAME	USES: HISTORIC	CONTEMPORARY	COMMERCIAL
STACH	*Stachys* sp.	hedgenettle	X		
TAOF	*Taraxacum officinale*	dandelion	X		X
TODI	*Toxicodendron diversilobum*	poison oak	X		
TRIFO	*Trifolium* sp.	clover	X		
TRLA4	*Trichostema lanceolatum*	vinegar weed	X		
TRLA16	*Tritelia laxa*	Indian potato	X		
VELA	*Verbena lasiostachys*	vervain			X
VICA5	*Vitis californica*	wild grape	X	X	

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GLOSSARY

Definitions. The following are definitions of terms used throughout this field guide. They are included here to standardize the approach to hierarchical vegetation classification in the Pacific Southwest Region.

'A' HORIZON: The surface horizon of a mineral soil having a maximum organic matter accumulation, maximum biological activity and/ or illuviation of materials such as iron and aluminum oxides and silicate clays.

ALLIANCE: A physiognomically uniform group of plant associations. It is used here to identify the dominant or diagnostic species in an existing vegetation classification.

ALLUVIUM: A general term for all detrital deposits resulting from the operations of modern rivers, thus including the sediments laid down in riverbeds, flood plains, lakes, fans at the foot of mountain slopes, and estuaries.

ARGILLIC (horizon): A illuvial horizon in which layer-lattice clays have accumulated by illuviation to a significant extent.

AWC (Available water holding capacity): The portion of water in a soil that can be readily absorbed by plant roots. The amount of water released between field capacity and the permanent wilting point. Usually measured as a function of soil texture, coarse fragment content and soil depth.

BROADCAST BURN: Prescribed burning in which a controlled fire is allowed to burn over a designated area for reduction of hazardous accumulations of debris (fuel) and/or as a silvicultural treatment. Usually used to remove logging slash and competing vegetation from a harvested area on slopes > 30%.

BURNING INDEX: A number (output of NDFRS) related to the contribution that fire behavior makes to the amount or effort needed to contain a fire in a particular fuel type within a specified area. Scale predicted flame length (Flame length = 1/10 X Burning Index).

CAMBIC (horizon): An altered horizon in which the texture of the fine-earth fraction is very fine sand, or loamy very fine sand of finer.

CHARACTERISTIC COVER: The percent cover one could expect to find in a plant association if a species were present. It is calculated by summing percent cover and dividing by the number of plots containing the species.

COARSE FILTER ANALYSIS: A type of ecological analysis that focuses on entire communities of organisms, rather than individual ones.

COARSE FRAGMENTS (soil): Particles in the soil that are greater than 2.0 mm and less than 25 cm in diameter.

COLLUVIUM: Unconsolidated earth material deposited on or at the base of steep slopes by mass wasting (direct gravitational action) and local unconcentrated runoff.

CONSTANCY: The percent of times a species was found to occur in a plant association, expressed as a percentage.

DUNNING SITE CLASS: A particular measure of 'site class' based on the height of the dominant trees in a stand at a given age. For example, if the average height attained by dominant and co-dominant trees in a fully stocked stand at the age of 100 years is 125 ft. then the site class is '1'. This site class is based on the Dunning site index curves for height at 300 years.

ECO CODE: A code provided by the Forest Service regional office, which is specific to each plant association and allows for common identification of each plant association.

ECOLOGICAL TYPE: A category of land having a unique combination of potential natural community, soil, landscape features, climate, and differing from other ecological types in its ability to produce vegetation and respond to management.

ECOSYSTEM MANAGEMENT: The skillful, integrated use of ecological knowledge at various scales to produce desired resource values, products, services and conditions in ways that also sustain the diversity and productivity of ecosystems.

EDP CODE: A four or five letter code used to abbreviate the species name of vascular plants in California. These codes are created through Electronic Data Processing (EDP). The codes use the first two letters of the genus and the first two letters of the specific epithet to distinguish species. If the plant is a variety a fifth letter will be added at the end. If the plant has a code that is the same as another species than a number will be added at the end.

ENDEMIC: A taxonomic category of organisms whose natural occurrence is confined to a certain region and whose distribution is relatively limited.

EXOTIC SPECIES: A non-native species.

FINE FILTER ANALYSIS: A type of ecological analysis that focuses on conserving individual species, rather than on entire communities of organisms.

FIRE BEHAVIOR: The manner in which a fire reacts to the variables of fuel, weather and topography.

FIRE CONTAINMENT: Restricting the spread of fire under prevailing conditions using natural barriers and/or constructed control lines to surround the fire and any spot fires.

FIRE CONTROL: Completion of a control line around a fire, any spot fires, and any interior "islands" to be saved; burning out of any unburned areas adjacent to the fire side of the control lines; cooling down all hot spots that are an immediate threat to the control lines until they can reasonably be expected to hold fire under foreseeable conditions.

FIRE EFFECTS: The positive and negative consequences of fire on the land and land resources, over its range of expected behavior.

FIRE SUPPRESSION: All the work and activities connected with extinguishing a fire, beginning with discovery and continuing until the fire is completely extinguished.

FRIGID (soil): A soil temperature regime where the mean annual soil temperature is lower than 8° C, and the difference between mean summer and mean winter soil temperatures is more than 5° C either at a depth of 50 cm from the soil surface or at a lithic or paralithic contact, whichever is shallower.

FUEL ACCUMULATIONS: Concentration of fuel, which is susceptible to ignition and combustion, generally expressed in tons per acre.

FUEL MODEL: A simulated fuel complex for which all the fuel descriptors required for the solution of a mathematical fire spread model have been specified.

HERPETOFAUNA: Amphibians, reptiles and turtles.

INDICATOR SPECIES: A species, which is sensitive to important environment features of a site such that its constancy or abundance reflect significant changes in environment.

INVASIVE WEEDS: Species that are able to proliferate and aggressively alter or displace indigenous biological communities.

JACKPOT BURN: Prescribed fire technique used in areas to reduce numerous individual concentrations of debris or hazardous fuels reducing fire hazard and/or creating regeneration sites.

LINE CONSTRUCTION: Manually or mechanically preparing a strip clear of flammable materials and exposing mineral soil to control a wildland fire.

LITHIC (contact): A boundary between soil and coherent underlying material.

LITTER: The top layer of the forest floor, typically composed of loose debris such as branches, twigs, and recently fallen leaves or needles; little altered in structure by decomposition.

LOAM: The textural class name for soil having a moderate amount of sand, silt, and clay. Loam soils contain 7-27% clay, 28-50% silt, and 23-52% sand.

LONG-TERM ECOLOGICAL STATUS: Long-term ecological status is described here using the Pacific Southwest Regions assignment of seral status to each species as an indicator of ecological status. Species were designated as indicators of early-seral, mid-seral or late-seral conditions as defined below:

Early-seral - species associated with very disturbed or young associations (pioneer species), with low abundance in stable associations, but invasive with high abundance in unstable associations.

Mid-seral - species whose abundance increases significantly with increased disturbance and maintains high abundance in recovered, stabilizing associations.

Late-seral - species typically found in undisturbed associations that decrease or maintain low abundance with increased disturbance.

MANUAL RELEASE: Manual release is the physical removal of competing vegetation in young forest stands by grubbing, snipping, or cutting with hand tools or chainsaw. Used to promote rapid growth of desirable vegetation and prevent unacceptable loss of growth and mortality.

MAST: Nuts, acorns, and similar products of hardwood species, which are consumed by animals.

MICRO-POSITION: The relative topographic location of a site on the landscape. The terms used in this guide are: ridge, summit, crest, upper one-third slope, middle one-third slope, lower one-third slope, toeslope, bottom, basin edge, and draw, intermittent stream bottom.

MICRO-RELIEF: The shape of the slope along both the vertical and horizontal contour. The terms for micro-relief in this guide are: convex, linear, concave, undulating, hummocky, mounded, and other.

MOLLIC (epipedon): A relatively thick, dark-colored, humus-rich surface horizon or horizons in which bivalent cations are dominant on the exchange complex and the grade of structure is moderate to strong.

NFDRS: National Fire Danger Rating System. A system used to uniformly describe the cumulative effects of weather on wildfire behavior.

NOXIOUS WEEDS: Those plant species designated as noxious weeds by the Secretary of Agriculture or by the responsible State official. Noxious weeds generally possess one or more of the following characteristics: aggressive and

difficult to manage, poisonous, toxic, parasitic, a carrier or host to serious insects or disease and being non-native or new or not common to the U.S. or parts thereof.

PARENT MATERIAL (soils): The horizon of weathered rock or partly weathered soil material from which the soil is formed.

pH (soil): The negative logarithm of the hydrogen ion activity (concentration) of a soil. The degree of acidity (of alkalinity) of a soil as determined by means of a suitable electrode or indicator at a specific moisture content or soil/water ratio, and expressed in terms of the pH scale.

PLANT ASSOCIATION: A potential natural plant community of definite floristic composition and uniform appearance that repeats itself across the landscape and takes the name of the projected climax type. In the case of an existing vegetation classification the definition changes to "takes the name of the dominant or diagnostic species".

POTENTIAL NATURAL VEGETATION: The biotic community that would be established if all successional sequences of its ecosystem were completed without additional human-caused disturbance under present environmental conditions.

PRESCRIBED BURN: Skillful application of fire to wildland fuels in either their natural or modified state, under specified environmental conditions to produce heat intensities and rate of spread required to accomplish certain planned benefits to meet resource management objectives.

PRIMARY REGENERATING SPECIES: The species which is higher in cover or in number of individual stems than any other species of the principle vegetation layer.

RADIATION INDEX: The ratio of total annual radiation on a given aspect and slope to total annual radiation received on a flat surface for a given latitude (Frank and Lee 1966).

RANGELANDS: Rangelands are lands that produce herbaceous forages and/or woody browse or mast biomass fed upon by wild and domestic ungulates: deer, elk, feral hogs, sheep, goats, cattle, horses and mules. In the case of the Northern Province of California, grasslands, meadows, chaparral, and oak woodlands are the primary biomes included in rangelands. Additionally, after wildfire or clearcut logging, conifer forestlands act as transitory rangelands until trees shade out herbaceous forage and browse plants.

RARE PLANT: A term applied to California native plant species that are limited in their distribution or population abundance.

RATE OF SPREAD: The increase in the perimeter, area, or advance of a fire as a function of time, usually expressed in chains per hour (1 chain = 66 feet) or acres per hour.

REPRODUCING SUCCESSFULLY: The species is present throughout the structural layers which are represented in the late seral stand.

REGENERATION: The renewal of a tree crop, whether by natural or artificial means. The act of replacing older trees.

RESIDUUM (Residual soil): Soil formed in place by the disintegration and decomposition of rocks and the consequent weathering of the mineral materials. Presumably developed from the same kind of rock as that on which it lies.

RESISTANCE TO CONTROL: The relative difficulty of constructing and holding a control line as affected by fuel, topography and soil, and by fire behavior.

RIPARIAN: Pertaining to the land, next to water, where plants dependent on a perpetual source of water occur.

SCORCH HEIGHTS: The maximum vertical height at which lethal scorching of foliage occurs. Below this height, all needles are brown and dead; above it, live and green.

SENSITIVE PLANT: A USDA Forest Service term used to designate plant species known or suspected to occur on National Forest system lands. This typically includes rare species included on Federal or State lists and/or the California Native Plant Society list 1B.

SERAL STAGE: A step or identifiable stage of a successional sequence (the sere). For example seral stages used in this guide are: shrub/forb, pole, early mature, mid-mature, late mature, and old growth.

SERIES: A vegetation series is an aggregation of taxonomically related plant associations, which takes the name of the (climatic) climax species that dominate (or have the potential to dominate) the principal vegetation layer in a time frame appropriate to the vegetation or taxonomic group under consideration.

SILVICULTURE: The art and science of establishing, tending, and protecting forests to produce desired vegetation conditions. This can include the production of wood fiber and/or controlling the establishment and composition of forests to meet specific management goals such as watershed protection, wildlife habitat, and recreation or scenic values.

SITE CLASS: A measure of the relative productive capacity of a site for the crop or stand under study, based e.g. on volume or height (dominant, co-dominant, or mean) or the maximum mean annual increment that is attained or attainable at a given age.

SITE PREPARATION: The reduction of obstacles and unwanted vegetation following harvest or natural disturbance and prior to reforestation.

SKELETAL: A soil with 35 percent or more (by volume) rock fragments (>2 mm) and 10 percent or more (by volume) particles less than 2.0 mm in diameter. Depending on the soil texture or percent clay, a soil can be described as Sandy-skeletal, Loamy-skeletal, or Clayey-skeletal.

SPECIALIST: A species adapted for life in a particular environment

SPECIES RICHNESS: The number of species in a sample unit.

SOIL TEMPERATURE REGIMES: Classes of soil temperature measured at 20 inches soil depth:

> **thermic -** The mean annual soil temperature is 15° C (59° F) or higher but lower than 22° C (72° F) and the difference between mean summer and mean winter soil temperature is more than 5° C at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.
>
> **mesic -** The mean annual soil temperature is 8° C (47° F) or higher but lower than 15° C (59° F) and the difference between mean summer and mean winter soil temperature is more than 5° C at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.
>
> **frigid -** The mean annual soil temperature is lower than 8° C (47° F) and the difference between mean summer and mean winter soil temperature is more than 5° C at a depth of 50 cm or at a lithic or paralithic contact, whichever is shallower.

STAND: Vegetation occupying a specific area and sufficiently uniform in species composition, age arrangement, structure and condition as to be distinguished from the vegetation on adjoining areas.

STREAM ORDER: A systematic numbering of streams according to flow levels and size. In the most widely used numbering system '1' refers to intermittent streams or smaller streams and '5' refers to rivers or main channels.

STRUCTURE: The size and arrangement (both vertical and horizontal) of trees within a forested stand.

SUB-SERIES: A vegetation sub-series is an aggregation of taxonomically related plant associations within a series that takes the name of that series followed by related species that are dominant or have indicator value across multiple plant associations.

SUBSOIL/SUBSURFACE: The soil layers underneath the topsoil. These layers are not seen from the surface and are not usually disturbed by soil tillage.

SURFACE HORIZON (soils): The upper 12-18 cm of soil that is usually manipulated when an area is plowed or cultivated.

TOPOGRAPHIC SHADING: The blocking of sunlight by surrounding slopes and hillsides, usually affecting vegetation in valley bottoms and riparian areas.

1 HOUR TIME LAG FUELS: Fuels consisting of dead herbaceous plants and roundwood less than one fourth inch in diameter. Also considered a 1-hour time lag fuels is the upper most layer of litter on the forest floor.

10 HOUR TIME LAG FUELS: Dead fuels consisting of roundwood one fourth inch to one inch in diameter. Also considered a 10-hour fuel component is very roughly, the layer of litter extending from just below the surface to three-quarters of an inch below the surface.

100 HOUR TIME LAG FUELS: Dead fuels consisting of roundwood in the size range of one to three inches in diameter. Also considered a 100-hour fuel component is very roughly, the forest floor from three fourths of an inch to four inches below the surface.

1,000 HOUR TIME LAG FUELS: Dead fuels consisting of roundwood three to eight inches in diameter. Also considered as a 1,000-hour fuel component is the layer the forest floor greater than four inches below the surface or both.